NOTICE

All drawings located at the end of the document.

FINAL DRAFT

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

WALNUT CREEK PRIORITY DRAINAGE
(Operable Unit No. 6)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

April 1991

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By [signature]
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LIST OF ACRONYMS

The following is a list of acronyms used throughout this work plan.

ACL	Alternative Concentration Limit
AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BCF	Bioconcentration Factor
BNA	Base-neutral acid extractable organics
BRAP	Baseline Risk Assessment Plan
CAD	Corrective Action Decision
CCR	Colorado Code of Regulations
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMP	corrugated metal pipe
CMS	corrective measures study
CRP	community relations plan
CSU	Colorado State University
CWA	Clean Water Act
DOE	Department of Energy
DQO	data quality objective
EEP	Environmental Evaluation Plan
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ER	environmental restoration
ERDA	Energy Research and Development Administration
FIDLER	Field Instrument for Detection of Low Energy Radiation
FS	feasibility study
FSP	field sampling plan
GAC	granular activated carbon
GC	gas chromatograph
GPR	ground penetrating radar
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HSP	Health and Safety Plan
HSU	Hydrostratigraphic unit
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
MATC	Maximum Allowable Tissue Concentration
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MSL	mean sea level
NCP	National Contingency Plan

NPDES	National Pollutant Discharge Elimination System
OU	Operable Unit
PARCC	precision, accuracy representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PID	photoionization detector
QAA	Quality Assurance Addendum
QA/QC	Quality Assurance/Quality Control
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Database System
RFI	RCRA facility investigation
RFP	Rocky Flats Plant
RI	remedial investigation (CERCLA)
ROD	Record of Decision
SAS	Special Analytical Services
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SID	South Interceptor Ditch
SIR	subsurface interface radar
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOPA	Standard Operating Procedure Addendum
TAL	target analyte list
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethylene
TCL	target compound list
TDS	total dissolved solids
TIC	tentatively identified compounds
TOC	total organic carbon
UV	ultraviolet
VOA	volatile organic analysis
VOC	volatile organic compounds
WQC	Water Quality Criteria
WQCC	Water Quality Control Commission

EXECUTIVE SUMMARY

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the North and South Walnut Creek drainages (Operable Unit Number 6) at the Rocky Flats Plant, Jefferson County, Colorado. This work plan includes a field sampling plan (FSP) that presents the investigation planned to evaluate the presence or absence of contamination at Individual Hazardous Substance Sites (IHSSs) within the North and South Walnut Creek drainages. The FSP developed in this work plan is based on the requirements of the Interagency Agreement (IAG) amongst the Department of Energy, Environmental Protection Agency, and the State of Colorado Department of Health. Twenty IHSSs, as identified in the IAG, are included in Operable Unit Number 6 (OU6). They are the A-series Detention Ponds, Ponds A-1 through A-4 (IHSSs 142.1 through 142.4) and IHSS 142.12, the B-series Detection Ponds, Ponds B-1 through B-5 (IHSSs 142.5 through 142.9), the North, Pond, and South Area Spray Fields (IHSSs 167.1, 167.2 and 167.3), the East Area Spray Field (IHSS 216.1), Trenches A, B and C (IHSSs 166.1 166.,2 and 166.3), the Sludge Dispersal Area (IHSS 141), the Triangle Area (IHSS 165) and the Old Outfall (IHSS 143). A Soil Dump Area (IHSS 156.2) has recently been added to this work plan because of its location along the Walnut Creek drainage, making a total of twenty-one IHSSs in OU6.

Section 1.0 of this Work Plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for each of the 21 IHSSs based on existing data. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU6. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU6. Section 5.0 outlines RFI/RI tasks to be performed while Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan and Environmental Evaluation Plan are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum and Standard Operating Procedure Addenda are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

The initial step in the development of the OU6 work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search and a review of the Rocky Flats Environmental Database System (RFEDS). Only a few limited investigations have been conducted at OU6 in the past. These investigations include sediment sampling in the A- and B-series ponds, limited sediment sampling in Walnut Creek, ongoing surface water, groundwater and sediment sampling programs along Walnut Creek, and plant-wide air quality monitoring.

Data quality objectives have been developed for this Phase I investigation. DQOs are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI. The DQO process is divided into three stages. Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving these goals.

After assessing the existing information for OU6, the following objectives of the Phase I RFI/RI have been identified:

- Characterize the physical and hydrogeologic setting of the IHSSs
- Assess the presence or absence of contamination at the sites
- Characterize the nature and extent of contamination at the sites, if present
- Support the Phase I Baseline Risk Assessment and Environmental Evaluation.

Within these broad objectives, site-specific data needs have been identified based on preliminary identification of contaminant-specific ARARs for OU6 and data needs for the Phase I Baseline Risk Assessment and Environmental Evaluation. The FSP developed in this work plan is based on the data needs and the requirements of the IAG. The FSP for each IHSS requires a combination of screening activities, sampling of soils, sediment and surface water, and well installation and sampling. Site-specific FSPs are briefly summarized below.

IHSS 141 - Sludge Dispersal Area The screening activity at the sludge dispersal area will be a radiological survey. Sampling activities will be limited to surface soil sampling. One monitoring well will be installed downgradient of the unit and sampled.

IHSS 142.1-9, 12 - Detention Ponds - A-Series and B-Series Surface water and sediment samples will be collected in several locations in each pond. Sediment samples will also be collected from Walnut Creek upgradient and downgradient of the ponds and between the ponds. Background surface water and sediment samples will be collected north and west of the Plant. A total of four monitoring wells will be installed and sampled in the alluvium downgradient of the dams at Ponds A-4 and B-5.

IHSS 143 - Old Outfall The screening activity at the Old Outfall site will be a radiological survey. Sampling will include surface soil sample collection at the existing surface and at the original surface below the fill, collection of soil samples to a depth of two feet below the original ground surface, and collection of composite fill samples. In addition, soil samples will be collected upslope from the Old Outfall where the surface runoff was channeled to this area.

IHSS 156.2 - Soil Dump Area Based on the findings of the aerial photograph and radiation survey reviews, surface and subsurface soil samples will be collected. One well will be installed within the unit and sampled.

IHSS 165 - Triangle Area A radiological survey and a soil gas survey will be the screening activities conducted at the Triangle Area. Surface soil samples will be collected from plume areas delineated during the screening. Subsurface samples will be collected from the same locations as the surface samples. Two alluvial ground water monitoring wells will be installed within the IHSS and sampled.

IHSS 166.1-3 - Trenches A, B and C The screening activity will consist of an electromagnetic geophysical survey which will be used to delineate the locations and extent of the trenches. Subsurface samples will be collected from borings drilled along the long axis of the trenches. One groundwater well will be installed east of this IHSS and sampled.

IHSS 167.1-3 - North Area, Pond Area and South Area Spray Fields Based on the findings of the aerial photograph review, surface and subsurface soil samples will be collected in each spray field area using a grid location system. Two alluvial groundwater monitoring wells will be installed and sampled, one downgradient of the North Area Spray Field and one downgradient of the South Area Spray Field.

IHSS 216.1 - East Area Spray Field Although the IAG does not specify field sampling at this site, limited surface and subsurface soil samples will be collected within this unit.

Data collected during the Phase I Walnut Creek drainage RFI/RI will be incorporated into the existing RFEDS database. These data will be used to better define site characteristics, source characteristics, and the nature and extent of contamination; to support the baseline risk assessment and environmental evaluation; and to evaluate potential remedial alternatives. An RFI/RI Report will be prepared summarizing the data obtained during the Phase I program and containing the Phase I Risk Assessment and Environmental Evaluation.

1.0 INTRODUCTION

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Walnut Creek Drainage (Operable Unit Number 6) at the Rocky Flats Plant, Jefferson County, Colorado. In this work plan, the existing information is initially summarized to characterize Operable Unit Number 6 (OU6) and a field sampling program is presented to assess the nature and extent of contamination in the twenty-one Individual Hazardous Substance Sites (IHSSs) along or within the North and South Walnut Creek drainages. These IHSSs are the Sludge Dispersal Area (IHSS 141); the ten detention ponds along North and South Walnut creeks (IHSS 142.1 through 142.9) and IHSS 142.12; the Old Outfall (IHSS 143); the Triangle Area (IHSS 165); Trenches A, B, and C (IHSSs 166.1, 166.2, and 166.3); the North Area, Pond Area, and South Area Spray fields (IHSS 167.1, 166.2, and 166.7) and the East Area Spray Field (IHSS 216.1). A Soil Dump Area (IHSS 156.2) has also been added to OU6 and is included in this work plan. The Phase I RFI/RI will be conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S.EPA 1988a) and Interim Final RCRA Facility Investigation (RFI) Guidance (U.S. EPA 1989b). The data generated will be used to begin developing and screening remedial alternatives and to evaluate the need for further studies for the 21 IHSSs. The data will be used to estimate risks to human health and the environment posed by each hazardous substance site.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at the Rocky Flats Plant. These investigations are pursuant to the U.S. Department of Energy (U.S. DOE) Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)], a Compliance Agreement between DOE, the U.S. Environmental Protection Agency (U.S. EPA), and the State of Colorado Department of Health (CDH) dated July 31, 1986, and an Inter-Agency Agreement (IAG) among DOE, EPA, and CDH dated January 22, 1991. The IAG addresses RCRA and CERCLA issues and has been integrated with the ER program. In accordance with the IAG, the CERCLA terms "Remedial Investigation" and "Feasibility Study" in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study" (CMS).

1.1 ENVIRONMENTAL RESTORATION PROGRAM

The ER Program is designed to investigate and clean up contaminated sites at DOE facilities. The ER Program being implemented is organized into five major activities. Activity 1 has already been completed at Rocky Flats Plant (U.S. DOE 1986a). This work plan is part of the Activity 2 program currently in progress for OU6 (North/and South Walnut Creek drainages).

- Activity 1 - Installation Assessment includes preliminary assessments and site inspections to assess potential environmental concerns.

- Activity 2 - Remedial Investigations include planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites, evaluate potential contaminant migration pathways, and perform baseline risk assessments.

- Activity 3 - Feasibility Studies evaluate remedial alternatives and develop remedial action plans to mitigate environmental problems identified as needing correction in Activity 2.

- Activity 4 - Remedial Design/Remedial Action includes design and implementation of site-specific remedial actions selected on the basis of Activity 3 Feasibility Studies.

- Activity 5 - Compliance and Verification implements monitoring and performance assessments of remedial actions and then verifies and documents the adequacy of remedial actions carried out under Activity 4.

1.2 WORK PLAN SCOPE

Existing information on OU6 has been obtained from numerous sources for use in work plan preparation. Section 1.0 of this work plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for each of the 21 IHSSs based on existing data. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU6. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU6. Section 5.0 outlines RFI/RI tasks to be performed. Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan (BRAP) and Environmental Evaluation Plan (EEP) are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum (QAA) and Standard Operating Procedure Addenda (SOPA) are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

1.3.1 Site Background and Plant Operations

The Rocky Flats Plant is a government-owned and contractor-operated facility that is part of the nationwide nuclear weapons production complex. The Plant was operated for the U.S. Atomic Energy Commission (AEC) from the Plant's inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the Plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by the DOE in 1977. Dow Chemical USA, an operating unit of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International succeeded Dow Chemical USA from July 1, 1975 to January 1, 1990, when EG&G Rocky Flats, Inc. succeeded Rockwell International.

The Rocky Flats Plant's primary mission is to produce metal components for nuclear weapons. These components are fabricated from plutonium, uranium and nonradioactive metals, principally beryllium and stainless steel. Parts made at the plant are shipped elsewhere for final assembly. When a nuclear weapon is determined to be obsolete, components of these weapons fabricated at the Plant are returned for special processing to recover plutonium and americium. Other activities at the Rocky Flats Plant include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in these research and production processes. Current waste handling practices involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and radioactive mixed wastes, and disposal of solid radioactive materials at another DOE facility. However, historically, Rocky Flats Plant operating procedures included both on-site storage and disposal of hazardous and radioactive wastes. Preliminary assessments under the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.

1.3.2 Previous Investigations

Various studies have been conducted at the Rocky Flats Plant to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations are referenced in numerous reports including the Final Phase II RFI/RI Work Plan for Operable Unit No. 2 (EG&G 1991a).

In 1986, two major investigations were completed at the Plant. The first was the ER Program Installation Assessment (U.S. DOE 1986a), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. A number of sites were identified that could potentially have adverse impacts on the environment. These sites were designated as Solid Waste Management Units (SWMUs) (renamed Individual Hazardous Substance Sites (IHSSs) in the January 22, 1991 IAG) by Rockwell International (1987a) and were divided into three categories:

1. Hazardous waste management units that will continue to operate and need a RCRA operating permit.

2. Hazardous waste management units that will be closed under RCRA interim status.

3. Inactive waste management units that will be investigated and cleaned up under Section 3004(u) of RCRA or under CERCLA. No RCRA or CERCLA regulatory distinction in the use of the terms "site," "unit," "SWMU," or "IHSS" is intended in this document.

The second major investigation completed at the Plant in 1986 involved a hydrogeologic and hydrochemical characterization of the entire Plant site. Plans for this study were presented in Rockwell International publications 1986b and 1986c, and study results were reported in Rockwell International publication 1986d. These investigations identified the twenty-one IHSSs that are included in OU6 based on their location adjacent to Walnut Creek.

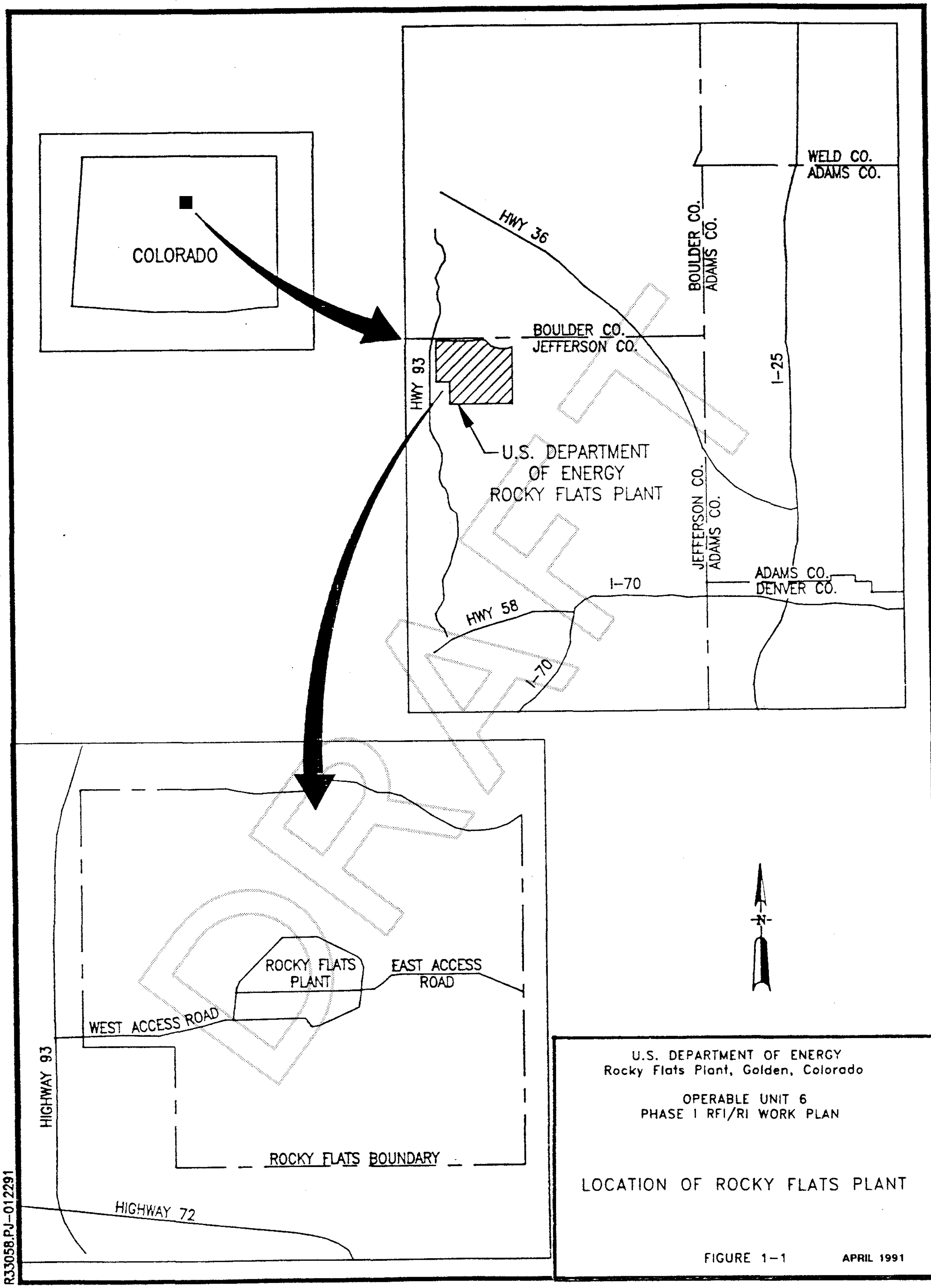
1.3.3 Physical Setting

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, which are located less than 10 miles to the northwest, east and southeast, respectively. The Plant consists of approximately 6,550 acres of federal land and occupies Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th principal meridian. Major plant buildings are located within a Plant security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The Plant is bounded on the north by State Highway 128. To the east is Jefferson County Highway 17, also known as Indiana Street; to the south are agricultural and industrial properties, and Highway 72; and to the west is State Highway 93 (Figure 1-2).

1.3.3.1 Topography and Drainage

The natural environment of the Plant and vicinity is influenced primarily by its proximity to the Front Range of the Rocky Mountains. The Plant site is located directly east of the north-south-trending Front Range, located about 16 miles east of the Continental Divide. The Rocky Flats Plant is located on a broad, eastward-sloping system of coalescing alluvial fans. These fans, created by the erosion of the



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U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCATION OF ROCKY FLATS PLANT

FIGURE 1-1 APRIL 1991

Front Range, extend approximately 5 miles to the east, where they terminate in low, rolling hills. The Plant is at an elevation of approximately 6,000 feet above mean sea level (msl). The Plant security area is located near the eastern edge of the fans on a pediment between stream cut gullies or arroyos (North Walnut Creek and Woman Creek) (Figure 1-2).

1.3.3.2 Surface Water Hydrology

Three streams drain the Rocky Flats Plant with flow generally from west to east. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1-2). Rock Creek drains the northwestern corner of the Plant and flows northeast through the buffer zone to its off-site confluence with Coal Creek. North and South Walnut creeks, and an unnamed tributary of North Walnut Creek drain the northern portion of the Plant security area. These three forks of Walnut Creek join in the buffer zone and flow to Great Western Reservoir, approximately 1 mile east of their confluence. The flow is diverted around Great Western Reservoir into Big Dry Creek by the Broomfield Diversion Ditch. Rock Creek, North and South Walnut creeks and the unnamed tributary are intermittent streams, with continuous flow occurring only after precipitation events and spring snowmelt. An east-west trending interfluve separates Walnut Creek from Woman Creek on the south. Woman Creek, a perennial stream, drains the southern Rocky Flats Plant buffer zone and flows eastward into Standley Lake Reservoir and Mower Reservoir. The South Interceptor Ditch is a ditch that flows intermittently and lies between the Plant and Woman Creek. The South Interceptor Ditch collects runoff from the southern Plant security area and diverts it to Pond C-2, where it is monitored in accordance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit.

1.3.3.3 Climate

The climate in the area of the Rocky Flats Plant is semi-arid, characterized by warm summers and dry, cool winters, as is typical of much of the central Rocky Mountain Region. However, the elevation of the Plant (6,000 feet) and the nearby slopes and canyons of the Front Range modify the regional climate. Winds, although variable, are predominantly from the west-northwest, with stronger winds occurring during the winter. The canyons along the Front Range tend to channel the flow during both upslope and downslope conditions, especially when there is strong atmospheric stability. The area occasionally experiences Chinook winds with gusts up to 100 miles per hour.

Rocky Flats meteorology is strongly influenced by the diurnal cycle of mountain and valley breezes. Two dominant flow patterns exist, one during daytime conditions, and one at night. During daytime hours as the earth heats, the mountains receive more direct sunlight than the plains and valleys. The result is a general trend for the air flow to travel toward the higher elevations (upslope). The general air flow pattern during upslope conditions for the Denver area is typically north to south with the flow moving up the South Platte River Valley and then entering the canyons into the Front Range. After sunset the air against the mountain side is cooled and begins to flow toward the lower elevations (downslope). The pattern for the Denver area during downslope is flow moving down the canyons of the Front Range onto the plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast.

Temperatures at Rocky Flats are moderate. On the average, daily summer maximum temperatures range from 55 to 85 degrees Fahrenheit (°F) and winter maximum temperatures range from 20 to 45 °F. Extremely warm or cold weather is usually of short duration. Based on precipitation averages collected between 1953 and 1976, the mean annual precipitation at the Plant is approximately 15 inches. Approximately 40 percent of the precipitation falls during the spring, predominantly as wet snow. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Thunderstorms from June to August account for about 30 percent of the total precipitation. Snowfall, generally occurring between October and May, averages 85 inches per year.

1.3.4 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area. Approximately 50 percent of the area within 10 miles of the Rocky Flats Plant is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land in 1973 was used for agriculture or was undeveloped. Since 1973, portions of this land have been converted to residential use, with several new housing subdivisions being constructed within a few miles of the buffer zone. One subdivision is located south of Jefferson County Airport, to the northeast, and several are located southeast of the Plant (EG&G 1991a).

A recent demographic study shows that approximately 2.2 million people lived within 50 miles of the Rocky Flats Plant in 1989 (U.S. DOE 1990a). Approximately 9,100 people lived within 5 miles of the Plant in 1989. The most populous sector lies to the southeast, toward Denver. Recent population estimates, registered by the Denver Regional Council of Governments (DRCOG) for the eight-county Denver metro region, have shown distinct patterns of growth during the first and second halves of the 1980s. Between 1980 and 1985, the population of the eight-county region increased by 197,890 -- a 2.4 percent annual growth rate. Between 1985 and 1989, a population gain of 71,575 was recorded, representing a 1.0 percent annual increase (the national average). The 1989 population showed an increase of 2,225 (or 0.1 percent) over 1988 (DRCOG 1989).

There are 8 public schools within 6 miles of the Rocky Flats Plant. The nearest educational facility is the Witt Elementary School, approximately 2.7 miles east of the plant buffer zone. The closest hospital is Centennial Peaks Hospital, located approximately 7 miles to the northeast.

The closest park and recreational area is Standley Lake Reservoir, approximately 5 miles southeast of the Plant. Boating, picnicking, and limited overnight camping are permitted. Several other small parks exist in communities within 10 miles. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of the Rocky Flats Plant, but all are more than 15 miles away.

Some of the land adjacent to the Plant's buffer zone is zoned for industrial development. Industrial facilities within 5 miles include the TOSCO laboratory (a 40-acre site located 2 miles south), the Great Western Inorganics Plant (2 miles south), the Frontier Forest Products yard (2 miles north), the Idealite Lightweight Aggregate Plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (a 990-acre site located 4.8 miles northeast). Several ranches are located within 10 miles of the plant, primarily in Jefferson and Boulder counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres) and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County, and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post 1989).

1.3.5 Ecology

A variety of plant life is found within the Plant boundary. Species are representative of lower mountainous and foothill ravine regions and include species of tall and short grass prairie. Riparian vegetation exists along the site's drainages and wetlands. None of these vegetative species present on the Rocky Flats facility have been reported to be on the endangered species list (EG&G 1991a). Disturbed areas of the Plant have revegetated since establishment of Rocky Flats Plant, as evidenced by the presence of disturbance-sensitive grasses like big bluestem (*Andropogon gerardii*) and sideoats grama (*Bouteloua curtipendula*).

The fauna inhabiting the Rocky Flats Plant and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer (*Odocoileus hemionus*), with an estimated 100 to 125 permanent residents. There are a number of small carnivores, such as coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*). A profusion of small herbivores can be found throughout the Plant and buffer zone, consisting of species such as the pocket gopher (*Thomomys talpoides*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*Microtus pennsylvanicus*) (U.S. DOE 1980).

Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), and vesper sparrows (*Pooecetes gramineus*). A variety of ducks (*Anas sp.*), killdeer (*Charadrius vociferus*), and red-winged blackbirds (*Agelaius phoeniceus*) are seen near pond areas. Mallards (*Anas platyrhynochos*) and other ducks frequently nest and rear young on several of the ponds. Common birds of prey in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (U.S. DOE 1980).

Bull snakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus sp.*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (U.S. DOE 1980).

1.3.6 Regional and Local Geology and Hydrogeology

The Rocky Flats Plant is located on a broad, eastward-sloping plain of overlapping alluvial fans along the Front Range of the Rocky Mountains. Figure 1-3 presents a generalized stratigraphic section of the Denver Basin bedrock and Figure 1-4 shows a local stratigraphic section of the Rocky Flats Plant. The surficial geology of the OU6 area is presented in Figure 1-5. Groundwater occurs under unconfined conditions in both the surficial units and the shallow bedrock units. In addition, groundwater occurs in deeper bedrock sandstones under confined conditions. Geologic interpretations are based on information from Hurr (Hurr 1976) and the Draft Geologic Characterization Report (EG&G 1990e). These interpretations are subject to change or modification based upon information gathered during the Phase II Geologic Characterization. A description of each of the geologic units is discussed in the following subsections.

1.3.6.1 <u>Rocky Flats Alluvium</u>

The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit in the Rocky Flats Plant area (Figure 1-6). The Rocky Flats Alluvium was deposited by braided streams that produced a series of coalescing alluvial fans. The alluvium is a broad deposit consisting of a topsoil layer underlain by up to 100 feet of varying amounts of silt, clay,and gravel. Unconfined groundwater flow occurs in the Rocky Flats Alluvium, which is relatively permeable. Recharge to the alluvium is from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. General water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. Groundwater flow is also controlled by pediment drainages in the top of the bedrock. Groundwater

136236

AGE	FORMATION	Thickness (feet)	GRAPHICS	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600'		Boulder conglomerate with occasional thin siltstone lenses
TERTIARY	Denver	870'		Yellowish-brown to grayish-olive fluvial tuffaceous claystone, siltstone, and sandstone interbedded with conglomerate and olive-gray mudflows
UPPER CRETACEOUS	Arapahoe	250'		Yellowish-gray to yellowish-brown sandstone; siltstone; and claystone; discontinuous conglomerate at base
UPPER CRETACEOUS	Laramie	700'		Gray, fine-to-medium-grained sandstone and silty clays; thin coal beds in lower part
UPPER CRETACEOUS	Fox Hills	75'		Tan, fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000'		Dark gray, silty shale and few thin, silty sandstones
UPPER CRETACEOUS	Niobrara	350'		Dark gray, very calcareous shale. "Foraminifers" abundant (Smoky Hills Member) Light gray, dense, fossiliferous limestone (Fort Hays Member)
UPPER CRETACEOUS	Benton	420'		Brown, sandy, fossiliferous limestone Dark gray shale with bentonite streaks; thin limestones in middle part; few cone-in-cone concretions in lower part Dark gray, brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So. Platte	270'		Light gray, fine-to-medium-grained sandstone, several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100'		Light gray, fine-to-coarse-grained, locally conglomeratic sandstone; frequent red and green siltstone interbeds
Jurassic	Morrison	365'		Gray to greenish-gray to red shale and siltstone; thin limestones in middle part; lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	110		Light tan siltstone and light red; silty shale; gypsiferous; sandstone at base and locally conglomeratic
TRI-ASSIC? / PERMIAN	Lykins	400'		Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120		Grayish-white, fine-to-medium-grained cross-bedded sandstone; conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000'		Red, fine-to-coarse-grained sandstone and conglomerate; arkosic; thin, lenticular red siltstones frequent throughout
PRECAMBRIAN				Gneiss, schist, and small granite intrusions

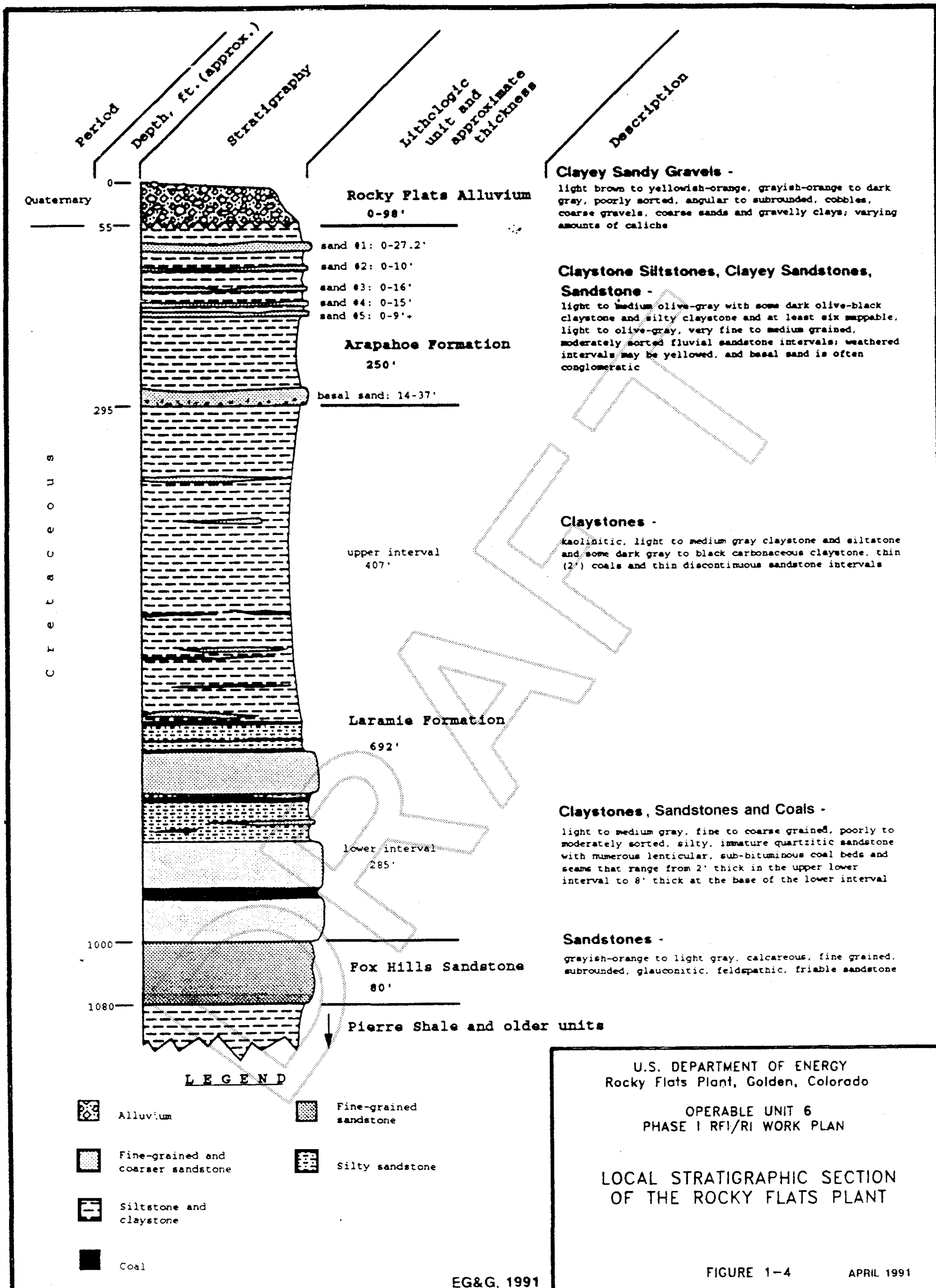
(modified from: Weimer, 1973)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

GENERALIZED STRATIGRAPHIC SECTION OF THE DENVER BASIN BEDROCK

FIGURE 1-3 APRIL 1991

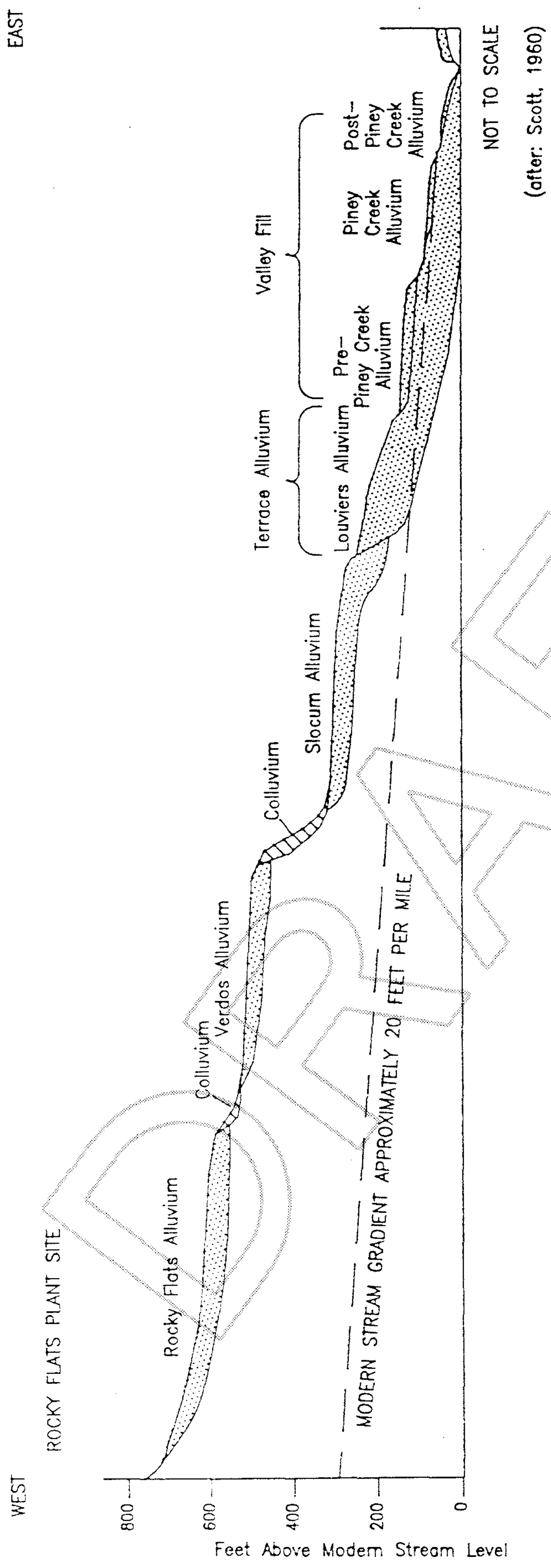


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCAL STRATIGRAPHIC SECTION OF THE ROCKY FLATS PLANT

FIGURE 1-4 APRIL 1991



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS EAST OF THE FRONT RANGE, COLORADO

FIGURE 1-6 APRIL 1991

levels in the Rocky Flats Alluvium rise in response to recharge in the spring and decline in the summer, fall, and winter. Fluctuations in the groundwater level vary approximately 2 to 25 feet within the Plant site vicinity (Hurr 1976). Discharge from the alluvium occurs at seeps in the colluvium that covers the contact between alluvium and underlying bedrock along the edges of the valleys. Most seeps flow intermittently. The Rocky Flats Alluvium thins and discontinues east of the Plant boundary and, therefore, does not directly supply water to wells located downgradient of the Rocky Flats Plant.

1.3.6.2 Other Alluvial and Colluvial Deposits

Various other alluvial deposits occur topographically below and east of the Rocky Flats Alluvium in the drainages of the Rocky Flats Plant. Colluvium (slope wash) mantles the valley side slopes between the Rocky Flats Alluvium and the valley bottoms. The colluvium is a product of mass wasting that collects on the sides and at the base of hills and slopes. These deposits tend to be poorly sorted mixtures of soil debris from bedrock clay and sand, mixed with gravel and cobbles derived from the older alluvium which caps the hills and ridges (Hurr 1976). The colluvium varies from a few inches to several feet in thickness and rests on bedrock and other alluvial material. In addition to the colluvium, remnants of younger terrace deposits including the Verdos, Slocum, and Louviers alluvial deposits occur occasionally along the valley sides slopes. Recent valley fill alluvium occurs in the active stream channels.

Unconfined groundwater flow occurs in these surficial deposits. Recharge occurs through precipitation, infiltration from streams during periods of surface water runoff, and by seeps discharging from the Rocky Flats Alluvium. Discharge occurs through evapotranspiration and by seepage into other geologic formations, subcrops, and streams. The direction of groundwater flow is generally to the east and downslope through colluvial materials, and then along the course of the stream in valley fill materials. During periods of high surface water flow, some of the water is lost to bank storage in the valley fill alluvium and then returns to the stream after the runoff subsides.

1.3.6.3 Arapahoe Formation

Underlying most of the surficial units at the Rocky Flats Plant is the Cretaceous Arapahoe Formation. The Arapahoe Formation is a fluvial deposit consisting primarily of siltstones and claystones, with some silty sandstones beneath the Plant. Formation thickness varies but maximum thickness is approximately 250 feet, and the unit is nearly horizontal beneath the Plant (less than 2° dip) (EG&G 1990g and 1990e). Claystones, which were deposited as overbank deposits, predominantly comprise the Arapahoe Formation. The sandstone in the upper Arapahoe Formation was deposited by a complex system of meandering streams flowing generally west to east off the Front Range. The lower Arapahoe sandstones were deposited by braided stream systems (EG&G 1990e). These occasional lenticular sandstone units in the Arapahoe Formation are composed predominately of fine-grained sands and silts, and their hydraulic conductivity is equivalent to or less than that of the overlying Rocky Flats Alluvium. The

Arapahoe Formation beneath Rocky Flats Plant, described by earlier RFI/RI studies, contains more clay and silt than typically described for other areas within the Denver Basin. There is a similarity of the siltstones and claystones beneath Rocky Flats to those of the Laramie Formation.

The Arapahoe Formation is recharged by groundwater from overlying surficial deposits and infiltration from streams. The main recharge areas are under the Rocky Flats Alluvium although limited recharge from the colluvium and valley fill alluvium likely occurs along the stream valleys (U.S. DOE 1990a). Recharge is greatest during the spring and early summer, when rainfall and stream flow are at a maximum and water levels in the Rocky Flats Alluvium are high. Groundwater movement on a regional basis is from west to east, in the Arapahoe Formation, toward the South Platte River in the center of the Denver Basin (Robson et al. 1981a).

1.3.6.4 Laramie Formation and Fox Hills Sandstone

The Laramie Formation underlies the Arapahoe Formation and is a continental deposit composed of a thick upper claystone unit and lower sandstone unit that contains coal beds up to 10 feet thick. The claystone is greater than 700 feet thick and is of very low hydraulic conductivity; therefore, the U.S. Geological Survey concluded that Plant operations will not impact any units below the upper claystone unit of the Laramie Formation (Hurr 1976).

The lower sandstone unit of the Laramie Formation, which is approximately 285 feet thick underlies the Fox Hills Sandstone to form a regionally important aquifer in the Denver Basin known as the Laramie-Fox Hills Aquifer. Near the center of the basin, the aquifer thickness ranges from 200 to 300 feet. West of the Plant, the Laramie-Fox Hills Aquifer can be seen in clay pits excavated through the Rocky Flats Alluvium. The steeply dipping beds of these units west of the Plant (approximately a 50° dip) quickly flatten to the east (less than 2° dip) (EG&G 1990g and 1990e). Recharge to this aquifer occurs along the rather limited outcrop area exposed to surface water flow and infiltration along the Front Range (Robson et al. 1981b).

2.0
SITE CHARACTERIZATION

Twenty Individual Hazardous Substances Sites (IHSSs) geographically located along or within the drainage areas of North and South Walnut creeks (Figure 2-1) have been designated as Operable Unit 6 (OU6) in the Environmental Restoration Interagency Agreement (IAG), dated January 22, 1991 (U.S. DOE 1990c). Ten of these IHSSs are detention ponds and include the A-series and B-series Ponds. The A-series Ponds, located on North Walnut Creek, are Ponds A-1, A-2, A-3, and A-4 (IHSSs 142.1 through 142.4), and the pond identified as Pond A-5, which will be referred to as the pond east of the confluence of North and South Walnut creeks and/or as IHSS 142.12 in this work plan. The B-series Ponds, located on South Walnut Creek, are Ponds B-1, B-2, B-3, B-4, and B-5 (IHSSs 142.5 through 142.9). The remaining ten IHSSs in OU6 are located on the banks and/or plateau areas which ultimately drain into North or South Walnut creeks or the unnamed tributary of North Walnut Creek (Figure 2-1). Four of these IHSSs are spray fields and are the North, Pond, South, and the East Area Spray Fields (IHSSs 167.1, 167.2, 167.3, and 216.1). Three are trenches and are Trenches A, B, and C (IHSSs 166.1, 166.2, and 166.3). The remaining three IHSSs are the Sludge Dispersal Area (IHSS 141), the Triangle Area (IHSS 165), and the Old Outfall (IHSS 143). In addition to these twenty IHSSs, IHSS 156.2, the Soil Dump Area has also been added to the Phase I OU6 investigation because of its location along the Walnut Creek drainage.

The initial step in the development of the OU6 work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search, which included references at the Rocky Flats Public Reading Room, various libraries within the Rocky Flats Plant, and a review of the Rocky Flats Environmental Database (RFEDS). Information concerning existing alluvial and bedrock groundwater wells within and near the South and North Walnut creek drainages has been collected for this study (Table 2-1). Personal communications with Plant personnel were also used as a source of information during the background data review so that each IHSS could be better described.

The twenty-one IHSSs in OU6 are discussed in detail in the following subsections. The location and description of each IHSS, the history of use, surface drainage, nature of contamination, previous investigations conducted at or near the individual IHSSs, geology, and hydrology are discussed. The A-series Ponds are discussed together in the following sections, as are the B-series Ponds, since these IHSSs have interrelated and similar histories. Also grouped together based on their similar operations and use are the North, Pond, and South area spray fields, as well as Trenches A, B, and C. The areal extent and boundary of each IHSS is based on a preliminary review of historical aerial photographs (U.S. EPA 1988b), and the historical operations of the unit. The boundaries for each IHSS in this work plan are the same as those established in the IAG except for the Old Outfall (Figure 2-1). The boundary for the Old Outfall has been enlarged based on historical maps of this IHSS. Where previous investigations

TABLE 2-1

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT 6

Well Number	Status	Ground Surface Elevation	Total Depth	Formation Completed In	Depth to Bedrock	Screen Interval
B206189	1, 4	5,984.5	36.61	Kcl	20.90	25.90-35.36
B206289	1	5,977.59	43.05	Kcl	14.80	32.37-41.82
B206489	1	5,969.14	11.35	Qrf/Kss(w)	7.50	3.25-10.0
7287	1	5,969.11	7.0	Qrf	6.50	3.50-8.76
B206389	1, 4	5,969.70	14.74	Qrf/Qaf	13.30	4.0-13.50
B206589	1	5,967.80	36.24	Kss(w)	9.50	23.50-35.14
7087	1	5,966.30	16.50	Qrf/Kss	13.50	3.50-16.26
B206689	1	5,959.31	19.41	Kcl	3.70	8.70-18.17
B206889	1	5,917.09	18.20	Kcl	3.0	8.0-17.45
B207189	1	5,884.80	77.76	Kss(u)	7.10	70.98-75.43
B207089	1	5,883.07	54.0	Kss(w)	6.0	31.32-53.0
B206989	1	5,882.42	22.5	Kcl	6.0	11.80-21.30
B206789	1, 4	5,927.90	20.52	Kcl	4.80	9.80-19.28
B207289	1	5,948.27	15.89	Kcl	0.20	5.20-14.65
0886	1	5,925.03	63.80	Kss(w)	5.0	59.08-63.79
0786	1	5,924.46	5.74	Qvf	6.0	3.0-5.74
6887	1	5,968.48	16.0	Qrf/Kss	15.30	11.15-15.75
6787	1	5,969.50	16.40	Qrf	16.80	11.72-16.46
7187	1	5,963.39	13.85	Qrf	13.50	3.50-13.57
4287	1	5,854.05	6.60	Qvf	6.10	3.0-6.36
0686	1	5,806.10	8.88	Qvf	8.0	3.28-8.88
0586	1	5,720.07	9.76	Qvf	8.0	4.40-9.76
B217089	2	5,919.0	--	--	7.5	--
B208789	1	5,909.03	12.29	Qvf	10.40	2.88-10.93
B210389	1	5,873.20	24.35	Kcl	8.60	13.61-23.07
B208689	1	5,867.60	23.07	Kcl	7.30	12.32-21.80
1786	1	5,865.26	13.98	Qvf/Kcl	12.50	3.73-13.98
1686	1	5,864.74	45.06	Kss(u)	7.0	39.06-45.06
B208589	1	5,856.50	5.07	Qvf	3.60	3.23-3.99

TABLE 2-1
ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT 6
(Continued)

Well Number	Status	Ground Surface Elevation	Total Depth	Formation Completed In	Depth to Bedrock	Screen Interval
B210489	1	5,856.40	8.67	Qc	7.0	2.98-7.41
B208389	1	5,876.80	9.03	Qc	7.30	3.37-7.30
B208489	1	5,876.30	30.49	Kcl	15.10	19.76-29.22
1886	1	5,882.82	7.50	Qaf	7.0	3.74-7.50
1486	1	5,844.71	55.36	Kss(w)	11.0	39.42-55.36
1386	1	5,837.22	9.50	Qvf	9.0	3.09-9.50
1586	1	5,845.61	14.69	Qvf/Kcl	12.50	4.09-14.69
B208289	1	5,850.70	16.16	Kcl	0.90	5.95-15.42
1286	1	5,780.56	11.30	Qvf	11.0	2.04-11.30
1186	1	5,712.19	10.25	Qvf	9.50	3.94-10.25
B208089	1	5,935.40	14.16	Qc	12.40	3.40-12.90
B208189	1	5,935.40	27.58	Kcl	11.90	16.90-26.34
B213789	4, 5	5,917.80	8.25	Qc	6.40	2.46-6.90
B220189	3	5,949.27	16.10	Qvf	14.90	12.91-14.86
3686	1	5,881.94	6.50	Qvf	5.50	3.50-6.49
P213889	4, 5	5,954.10	22.03	Kss(w)	8.30	11.30-20.83
3486	1	5,910.44	56.25	Kss(w)	16.10	44.24-56.25
3586	1	5,909.20	11.60	Qvf/Kcl	10.30	4.86-11.60
P213989	4, 5	5,954.30	7.20	Qrf	6.70	3.29-6.93
P219489	4, 5	5,959.50	22.90	Qrf	22.45	18.48-22.90
P219589	4, 5	5,963.80	26.99	Qrf	25.20	21.27-25.70
P207789	1, 4	5,965.88	28.63	Kcl	12.90	17.90-27.34
P209689	1, 4	5,962.63	27.93	Kcl	12.20	17.20-26.67
2986	1	5,958.26	8.77	Qrf	8.70	2.83-8.77
P218389	4, 5	5,956.20	13.77	Qrf	12.0	8.06-12.56
0460	1	5,962.0	17.78	--	--	--
P207889	1, 4	5,962.82	8.95	Qrf	7.20	3.26-7.70
P209789	1, 4	5,962.82	13.75	Qrf	12.0	3.0-12.50
2886	1	5,961.23	8.60	Qaf	8.40	4.03-8.60

TABLE 2-1
ALLUVIAL AND BEDROCK GROUNDWATER WELLS
IN THE VICINITY OF OPERABLE UNIT 6
(Concluded)

Well Number	Status	Ground Surface Elevation	Total Depth	Formation Completed In	Depth to Bedrock	Screen Interval
2786	1	5,961.86	133.0	Kss(u)	9.20	128.50-133.0
P209589	1, 4	5,948.17	19.77	Kcl	4.10	9.07-18.52
P208889	1, 4	5,947.30	99.16	Kss(u)	3.50	87.76-96.94
P207989	1, 4	5,963.09	21.73	Kcl	6.0	11.0-20.48
P210289	1, 4	5,967.03	22.27	Kcl	6.60	11.57-21.0
3787	1	5,967.03	9.0	Qrf	8.50	3.50-8.77
P207689	1, 4	5,966.32	14.36	Qrf	12.60	3.64-13.10
3786	1	5,792.02	8.55	Qvf	7.75	3.29-8.55
3886	1	5,728.13	8.50	Qvf	10.0	2.91-8.50
0181	3	5,718.90	22.05	--	--	--
1186	1	5,712.19	10.25	Qvf	9.50	3.94-10.25
0586	1	5,720.07	9.76	Qvf	8.0	4.40-9.76
0486	1	5,636.60	14.92	Qvf	15.0	3.52-14.92

Key to Status:
1 - Active Well
2 - Abandoned Borehole
3 - Inactive Well
4 - Borehole Sampled
5 - Observation Well

Key to Geologic Strata:
Qrf - Rocky Flats Alluvium
Qc - Colluvium
Qvf - Valley Fill Alluvium
Kcl - Bedrock Weathered Claystone
Kss(u) - Bedrock Unweathered Sandstone
Kss(w) - Bedrock Weathered Sandstone
Qaf - Artificial Fill
Kss - Undifferentiated Bedrock Sandstone

Source: EG&G 1990c

have been conducted at or near a unit, some of the analytical data, where appropriate, are included for reference in the following sections. The inclusion of these data is for informational purposes only. No conclusions are made in this work plan regarding the presence or absence of contamination based on these data. The geology of each IHSS is based on the lithology of nearby wells, personal communications with EG&G personnel and the Draft Geologic Characterization Report prepared by EG&G (EG&G 1990e). In addition to the review of each IHSS, a conceptual model for each IHSS or similar IHSSs was then developed based on the existing data for each. These models identify and describe contaminant sources, potential migration and exposure pathways and receptors.

Also discussed in the following section are North and South Walnut creek drainage systems adjacent to the Rocky Flats Plant. North and South Walnut creeks and the unnamed tributary of North Walnut Creek constitute the drainage system which provides a common physical setting for all the IHSSs in OU6.

2.1 NORTH AND SOUTH WALNUT CREEKS

The Rocky Flats Plant is geographically located on a plateau which is bounded on the north by North Walnut Creek. North and South Walnut creeks are intermittent streams that receive surface runoff from the northern and eastern portion of the Plant facility and adjoining buffer zone. An unnamed tributary (located ½ mile north of the facility and north of North Walnut Creek) receives surface runoff from the northern buffer zone. All three of these creeks merge into Walnut Creek within the buffer zone about 1 mile northeast of the Perimeter Security Zone (PSZ) (Figure 2-1). Walnut Creek flows toward Great Western Reservoir located approximately ⅓ mile east of the eastern boundary (Indiana Street) of the Rocky Flats Plant. The water from Walnut Creek is diverted around Great Western Reservoir by the Broomfield Diversion Ditch and is carried to Big Dry Creek.

The headwaters of North Walnut Creek originate within the Upper Church Ditch, approximately 1½ miles west of Highway 93 near Coal Creek (Figure 1-2). This ditch splits within the western buffer zone forming McKay Ditch and Church Ditch. McKay Ditch becomes North Walnut Creek just north of the Rocky Flats security area (Figure 1-2). North Walnut Creek continues for approximately 3 miles before converging with South Walnut Creek to form Walnut Creek.

South Walnut Creek originates near the center of the Rocky Flats Plant security area and bisects the eastern half of the security area. South Walnut Creek converges with North Walnut Creek approximately one mile east of the eastern boundary of the main security area (Figure 2-1). The original headwaters of South Walnut Creek were backfilled during construction of the Plant's facilities; therefore, flow begins near a buried culvert west of Building 991.

The natural drainage of both North and South Walnut creeks have been modified in the OU6 area by the construction of several detention ponds. These detention ponds serve to temporarily detain surface runoff draining from the Plant facilities and buffer zone in order for the water to be sampled and analyzed prior to release downstream. These detention ponds are also used for spill control management. Four detention ponds (the A-series Ponds) were built in North Walnut Creek and five detention ponds were built in South Walnut Creek (the B-series Ponds). Following is a brief discussion of the drainage system near these detention ponds.

The four A-series detention ponds (Ponds A-1 through A-4) have been built in North Walnut Creek, northeast of the main security area of the Plant facility (Figure 2-1). Surface water in North Walnut Creek flows eastward in its original channel to just west of Pond A-1. The A-1 Bypass diverts this runoff around Ponds A-1 and A-2 and channels it into Pond A-3, where the water is temporarily detained. Currently ponds A-1 and A-2 receive no upstream runoff from North Walnut Creek. These ponds are used primarily for spill control management and to detain runoff from the area immediately adjacent to these ponds. The water collected in Ponds A-1 and A-2 is not released downstream but is disposed of through spray and pond evaporation. Pond A-3 receives surface water from North Walnut Creek and runoff from the northern production facilities via the A-1 Bypass. Periodically, water in Pond A-3 flows into Pond A-4. The water in Pond A-4 is treated by a granular activated-carbon (GAC) system before being discharged into North Walnut Creek. Downstream of Pond A-4 and west of Indiana Street, water from Walnut Creek is temporarily detained in a pond, IHSS 142.12, until it reaches a high enough level to flow out and downstream into Walnut Creek toward Great Western Reservoir. The effluent from this pond is sampled daily when discharging downstream. The water in Walnut Creek is diverted around Great Western Reservoir by the Broomfield Diversion Ditch, which carries water to Big Dry Creek.

The B-series detention ponds (Ponds B-1 through B-5) have been built in South Walnut Creek east of the main security area of the Plant facility (Figure 2-1). Ponds B-1 and B-2, are primarily used for spill control management and to detain surface runoff from the upstream portion (eastern part) of the facility. The water collected in these ponds is not discharged downstream but disposed of through spray field evaporation similar to Ponds A-1 and A-2. Pond B-3 receives effluent from the Sewage Treatment Plant (STP) (Building 995), local surface runoff, and intercepted groundwater from a seepage area near the solar evaporation ponds (Figure 2-1) (U.S. EPA 1984). Water in Pond B-3 is continuously discharged to Pond B-4 under an NPDES permit (Permit Number CO-0001333). The water in this pond is sampled and analyzed three days a week. Water in Pond B-4 is continuously released to Pond B-5. Pond B-5 receives water not only from Pond B-4 but from surface runoff from the Central Avenue Ditch located south of the B-series Ponds (Figure 2-1). This ditch receives surface runoff that originates near the eastern production facilities. The water in Pond B-5 is not discharged to South Walnut Creek but periodically pumped to Pond A-4, where the water is treated through a GAC system before being discharged downstream into Walnut Creek.

North and South Walnut creek drainages are included in the Plant-wide Radioactive Ambient Air Monitoring Program (EG&G 1991d). Monitoring stations for this program are shown on Figure 2-1. Seven stations currently exist in the Walnut Creek drainage and 3 additional stations are proposed in OU6. The Plant-wide air monitoring program should be consulted for details on sampling frequency, procedures and analytical program.

2.2 A-SERIES PONDS A-1, A-2, A-3, A-4 (IHSSs 142.1, 142.2, 142.3, 142.4), and IHSS 142.12

2.2.1 Location and Description

Ponds A-1, A-2, A-3, and A-4 (IHSSs 142.1 through 142.4) are built in North Walnut Creek, northeast of the main security area of the Rocky Flats Plant (Figure 2-2). IHSS 142.12, the pond located approximately 2,500 feet east of the confluence of North and South Walnut creeks and immediately west (upstream) of Indiana Street will be discussed with the A-series Ponds. The size of these ponds vary seasonally but are usually maintained at 10 percent capacity. The estimated storage capacity for Ponds A-1, A-2, A-3, and A-4 are 1,660,000; 6,700,000; 14,110,000; and 3,090,000 gallons, respectively. These ponds were generally constructed by the placement of an earthen embankment across the North Walnut Creek drainage. Outlets and spillways were constructed in some of the ponds. Outlets are used to regulate downstream flow from the ponds with spillways used to channel excess water around the embankment when the ponds are near their full capacity. As-built drawings for ponds A-2, A-3, and A-4 are contained in Appendix A (EG&G 1991c). A description of surface water flows through these ponds is contained in subsection 2.1.

2.2.2 History

The A-series Ponds are used primarily to capture and control surface water runoff from the northern part of the Rocky Flats production facilities and from North Walnut Creek. Historically, the A-series Ponds have received discharges from several different sources. Between 1952 and 1979, Pond A-1 was used to hold laundry wastewater that contained nitrates and radioactive substances, including plutonium and uranium, that was discharged into North Walnut Creek from the northern production facilities. Pond A-1 also received process liquid waste, cooling tower blowdown and steam condensate discharges, which contained chromates and algicides. After the construction and completion of Pond A-2 (prior to 1978) the water of Pond A-1 was allowed to flow into Pond A-2 where the water was disposed of by natural and spray evaporation (Hurley 1979).

These discharges, although long since discontinued, produced significant amounts of plutonium in the stream sediments of North Walnut Creek and in the sediments of Pond A-1 (U.S. DOE 1980). Pond A-1 is presently used for spill control management and receives only local surface runoff and seepage that may occur in the area. The water collected in this pond is currently disposed of through spray evaporation. Pond A-2 received process wastewater and laundry wastewater from Ponds A-1 and B-2 (IHSS 142.6). The water from Pond B-2 was pumped to Pond A-2. The water from Pond A-2 has always been disposed of by natural and spray evaporation. Pond A-2 is presently used for spill control management, like Pond A-1, and receives only local surface runoff and seepage that may occur near this area.

Pond A-3, constructed in 1971, was used to impound surface water runoff from the northern Plant facilities and North Walnut Creek prior to being discharged downstream. Presently, Pond A-3 collects surface runoff from the northern production facilities and North Walnut Creek as waters originating upstream in North Walnut Creek are diverted around Ponds A-1 and A-2 by the A-1 Bypass and channelled into Pond A-3. The water is temporarily detained in Pond A-3 before being released into Pond A-4.

Pond A-4, constructed in 1980, historically received water from Pond A-3. Presently, Pond A-4 receives water from Ponds A-3 and B-5 (the water from Pond B-5 is pumped into Pond A-4). The water in Pond A-4 is treated by a GAC system before being discharged downstream into Walnut Creek.

IHSS 142.12, or the pond east of the confluence of North and South Walnut creeks is used to take flow measurements of Walnut Creek. This is accomplished using two Parshall Flumes (6-inch throat and 36-inch throat). Sediments transported by North and South Walnut creeks may settle out in IHSS 142.12 due to the quiescent conditions of this pond (Blaha 1990). The effluent from this pond is sampled on a daily basis when discharging. Discharging occurs when the capacity of the pond reaches a high enough capacity to flow out and downstream into Walnut Creek.

2.2.3 Surface Drainage

The surface drainage system near Detention Ponds A-1 through A-4 and IHSS 142.12 is discussed in subsection 2.1. Ponds A-1 and A-2 receive local runoff and seepage which may occur near these ponds. Pond A-3 receives surface runoff from the northern Plant facilities and North Walnut Creek. Pond A-4 receives water from Pond A-3, Pond B-5 and any local runoff or seepage which may occur in this area. IHSS 142.12 receives treated water that is discharged downstream of Pond A-4 and runoff that may occur in the immediate area.

2.2.4 Nature of Contamination and Previous Investigations

The A-series detention ponds have received considerable attention over the last several years, and numerous investigations have been conducted on the water and sediment quality of the ponds and stream sediments of North Walnut Creek. Included in these studies was a 1970 study conducted by the

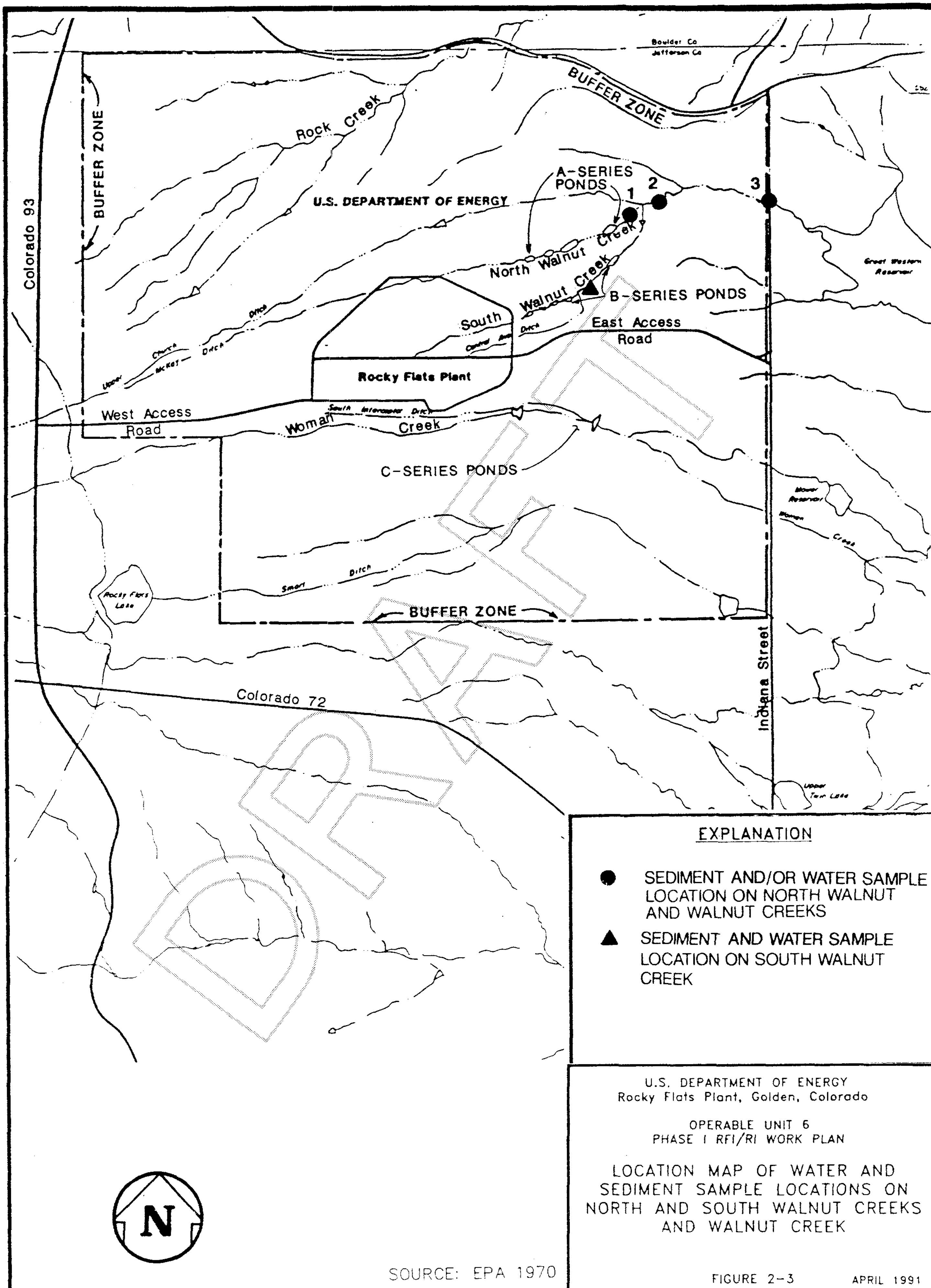
EPA (U.S. EPA 1970), a 1979 study on radioactivity levels associated with the pond sediments (Hurley 1979), a 1980 study by D. Paine on plutonium in freshwater systems at Rocky Flats (Paine 1980), and a 1986 study conducted as a requirement for a RCRA Part B permit application (Rockwell 1988). In addition to the above studies, analytical results from the monthly surface water samples collected during 1989 from the A-series Ponds and IHSS 142.12 have been summarized as part of this work plan (EG&G 1990c).

The study conducted in February 1970 by EPA involved the analysis of two water samples and three bottom sediment samples from Walnut Creek (U.S. EPA 1970). The bottom sediment samples were collected by scraping the bottom area below the water line with a hand trowel. Grab samples of water were collected in 1-gallon plastic containers with 2 to 5 gallons collected per sample. A water and a bottom sediment sample were collected at Location 1 (Figure 2-3) approximately 50 feet upstream of the confluence of North and South Walnut creeks. The second sample, in which only a bottom sediment sample was collected (Location 2), was about 50 feet downstream of the confluence (Figure 2-3). The third sample (Location 3) was collected from Walnut Creek at Indiana Street. The water sample at this location was collected on the east side of Indiana Street and the bottom sediment sample was collected on the west side (Figure 2-3). Analyses of these water and sediment samples are tabulated in Table 2-2.

The 1979 study concerning radioactivity associated with the pond sediments concluded that most of the plutonium was in the pond sediments and that the amount of plutonium in the water depended to a great extent on the amount of suspended material in the sample. Sediments showed an extremely high affinity for plutonium; the adsorption and fixation of plutonium by sediments was rapid and essentially irreversible. The highest plutonium concentrations found within the pond sediments were found at subsurface depths rather than on the sediment surface (Hurley 1979).

The 1980 study by D. Paine, was conducted to determine the behavior of plutonium in the freshwater systems at Rocky Flats Plant (Paine 1980). In this study, sediment cores were taken at 5 cm intervals on a monthly basis from Pond A-1 during the study period (spring of 1971 through the summer of 1973). These core samples were taken to determine the vertical distribution of plutonium in the pond sediments. Surface water samples and water samples were collected at 0.5 meter increments from the pond surface to the sediment/water interface.

The average or mean plutonium concentrations (Pu-239 and Pu-240) in unfiltered water and surface sediments taken from Pond A-1 during this study period are illustrated in Figure 2-4. Reconstruction activities of Pond A-1 resulted in an increase in plutonium concentrations in the surface water samples as observed in Figure 2-4, but not in the ponds sediments. The sediment samples collected at depth showed no significant vertical variation in plutonium concentrations with depth, probably because of the



EXPLANATION

● SEDIMENT AND/OR WATER SAMPLE LOCATION ON NORTH WALNUT AND WALNUT CREEKS

▲ SEDIMENT AND WATER SAMPLE LOCATION ON SOUTH WALNUT CREEK

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LOCATION MAP OF WATER AND SEDIMENT SAMPLE LOCATIONS ON NORTH AND SOUTH WALNUT CREEKS AND WALNUT CREEK

FIGURE 2-3 APRIL 1991

TABLE 2-2

WATER AND SEDIMENT ANALYTICAL DATA ALONG WALNUT CREEK

Dissolved Radioactivity in Water Samples (pCi/l)

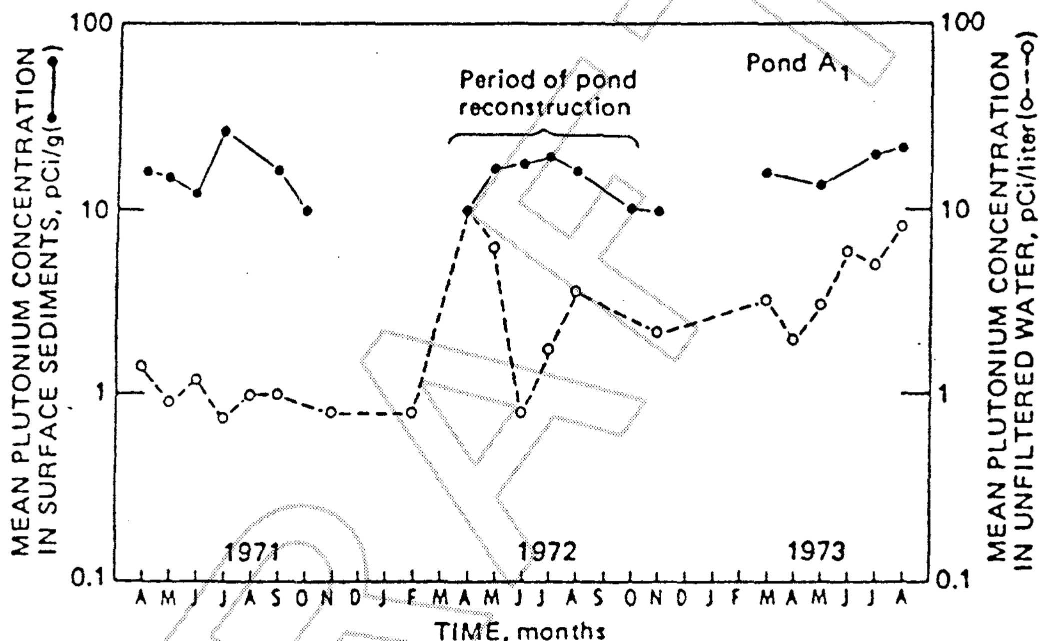
Station	Gross Alpha	Tritium	Sr-89	Sr-90	Total Alpha Radiation	Uranium[1]	Pu-239
Location 1	0.9	N.D.	0.1	0.7	<0.1	2.7	0.02
Location 3	0.6	N.D.	0.1	0.6	<0.1	4.8	0.05

Radioactivity in Bottom Sediment Samples (pCi/g)

Station	Gross Alpha	Sr-90	Total Alpha Radiation	Uranium[1]	Pu-239
Location 1	10	0.1	5.4	2.3	0.50
Location 2	17	0	2.8	1.0	3.41
Location 3	14	0.1	4.1	2.1	0.92

Note: [1] Concentration in $\mu g/l$
N.D. - Not Determined
(See Figure 2-3 for station locations)

Source: EPA 1970



SOURCE: PAINE, 1980

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MEAN PLUTONIUM CONCENTRATIONS IN SURFACE SEDIMENTS (pCi/g) AND MEAN PLUTONIUM CONCENTRATIONS IN UNFILTERED WATER (pCi/l) FOR POND A-1

FIGURE 2-4

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shallow nature of pond A-1. In addition, the plutonium concentrations detected in the pond sediments of Pond A-1 are relatively low in comparison to the B-Series Detention Ponds (see Section 2.3.4). This may be due to the relatively low percentage of plutonium in the filterable fraction of the water samples (Table 2-3). In this 1980 study, Paine concluded that sediments (especially clays) appear to be the major reservoir for ultimate plutonium deposition and that relatively insignificant transport of plutonium through biotic systems to man exist.

The 1986 study "Trends in the Rocky Flats Surface Water Monitoring" summarized analytical data collected between 1980 and 1985. During this 5-year period, water samples collected from Pond A-1 had maximum plutonium concentrations of 0.24 pCi/l. Water quality in Pond A-2 was reported to be similar to the water in Pond A-1 with maximum plutonium concentrations of 0.17 pCi/l. Higher concentrations of uranium-233/234 (6.4 pCi/l) and uranium-238 (5.8 pCi/l) were measured from Pond A-2, as compared to samples from Pond A-1. Pond A-3's water was reported to contain elevated uranium-233/234 and uranium-238 concentrations like Pond A-2. Water quality of Pond A-4 was similar to background concentrations (Rockwell 1988).

A surface water monitoring program was established several years ago at Rocky Flats facility and is presently being supervised by EG&G personnel. Numerous established surface sampling locations along the drainage areas of North and South Walnut creeks and within the A- and B-series Ponds are sampled on a monthly basis, providing there is water present and the water is not frozen. Analytical results from surface water samples collected during 1989 from Ponds A-1 through A-4 were reviewed for this work plan to provide more recent data on the ponds (Figure 2-2). These surface water samples collected, SW-A1, SW-A2, SW-A3, and SW-A4, from Ponds A-1 through A-4, respectively, are collected at the deepest part of the pond and analyzed for radionuclides, metals, and organics. The maximum concentrations detected during 1989 for most analytes in each of the ponds have been tabulated in Table 2-4. These data have not yet been validated, therefore, there are some uncertainties in the unvalidated data. Several sediment sampling locations have also recently been established along North and South Walnut creeks; however, limited chemical analytical data are available at this time from samples that have been collected.

The effluent, if any, from the pond east of the confluence of North and South Walnut creeks (IHSS 142.12) is sampled daily when discharging downstream into Walnut Creek. On-site analytical results from the effluent of IHSS 142.12 during August, September, and October of 1990 have been summarized for this report. Maximum concentrations for radionuclides include plutonium-239/240 (0.022 ± 0.017 pCi/l), americium-241 (0.035 ± 0.039 pCi/l), uranium-233/234 (1.11 ± 0.40 pCi/l), and uranium-238 (1.09 ± 0.26 pCi/l). These data results are recorded in the monthly Environmental Monthly Reports prepared by EG&G (EG&G 1990f).

TABLE 2-3

PERCENT OF PLUTONIUM ISOTOPES ASSOCIATED WITH FILTERABLE FRACTION OF WATER SAMPLES FROM ROCKY FLATS PONDS

Pond	Filterable fraction*
B-1	90 ± 6
B-2	80 ± 12
B-3	80 ± 8
B-4	70 ± 12
C-1	30 ± 30
A-1	35 ± 20

* Mean ± standard error

Source: Paine 1980

TABLE 2-4

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED IN PONDS A-1, A-2, A-3, AND A-4 IN 1989

	Pond A-1	Pond A-2	Pond A-3	Pond A-4
Analyte	SW-A1	SW-A2	SW-A3	SW-A4
Radionuclides	Concentration[2] (pCi/l)	Concentration[2] (pCi/l)	Concentration[2] (pCi/l)	Concentration[2] (pCi/l)
Americium-241	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.01
Cesium-137	0.5 ± 0.6	0.1 ± 0.5	0.4 ± 0.5	0.3 ± 0.5
Gross Alpha	14.0 ± 7.0	17.0 ± 7.0	10.0 ± 4.0	10.0 ± 4.0
Gross Beta	18.0 ± 4.0	23.0 ± 4.0	14.0 ± 2.0	15.0 ± 0.3
Plutonium-239	0.02 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.3 ± 0.3
Radium 226	0.3 ± 0.2	0.4 ± 0.2	0.2 ± 0.4	0.3 ± 0.2
Strontium 90	0.6 ± 0.4	0.5 ± 0.5	0.7 ± 0.4	0.8 ± 0.5
Tritium	240.0 ± 220.0	320.0 ± 230.0	270.0 ± 230.0	340.0 ± 210.0
U-233/234	2.8 ± 0.4	3.0 ± 0.4	2.9 ± 0.6	3.4 ± 0.6
U-235	0.2 ± 0.1	1.3 ± 0.3	0.1 ± 0.1	0.2 ± 0.1
U-238	5.9 ± 0.6	6.7 ± 0.6	4.2 ± 0.5	5.0 ± 0.5
Total Uranium[1]	9.2	N.A.	6.5	8.1
Metals	Concentration[2] (mg/l)	Concentration[2] (mg/l)	Concentration[2] (mg/l)	Concentration[2] (mg/l)
Strontium	0.321	N.A.	N.A.	N.A.
Magnesium	21.40	20.80	11.30	15.90
Manganese	0.163	0.259	0.0860	0.0823
Iron	0.395	0.706	0.710	0.207
Zinc	0.0900	0.0928	0.179	0.0420
Mercury	N.A.	0.0002	0.0005	0.0006
Organics	Concentration[2] (µg/l)	Concentration[2] (µg/l)	Concentration[2] (µg/l)	Concentration[2] (µg/l)
Phenol	11.0	18.0	32.0	33.0

(see Figure 2-2 for Surface Water locations)

Note: [1] No Units are available
[2] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

N.A. = Not Analyzed
Source: EG&G 1990c

Discharges from Ponds A-3 and A-4 are presently monitored to comply with NPDES permit requirements with limitations placed on Pond A-3 for nitrate concentrations and pH values. Pond A-4 has limitations on the amount of sediment it can release. Plutonium-239/240, americium-241, uranium-234, and -238, and tritium are also monitored in the discharges from these ponds (Rockwell 1987a). Pond A-3 is discharged to Pond A-4 when necessary and the water in Pond A-4 is treated by a granular activated carbon (GAC) system before being discharged into North Walnut Creek. Flow measurements and water quality samples are collected from Pond A-4 during discharge. The analytical data results are presented in the monthly environmental monitoring report prepared by EG&G (EG&G 1990f).

Local runoff and groundwater seepage that naturally collect in Detention Ponds A-1 and A-2 are disposed of through evaporation. High-pressure spraying of water from Ponds A-1 and A-2 over the ponds' surface facilitates the evaporation process (Rockwell 1988). These ponds are not normally sampled since there are no surface water releases.

2.2.5 Geology and Hydrology

The geology near and beneath the A-series Ponds has been characterized through lithologic information obtained from monitoring wells upgradient of the A-series Ponds, within the North Walnut Creek drainage, and adjacent to Pond A-3. In addition, geologic maps from RFEDS and from the Draft Geologic Characterization Report (EG&G 1990e) were used. The monitoring well (well No. 1286) adjacent to Pond A-3 encountered approximately 11 feet of valley fill alluvium (Figure 2-2). It is estimated that the thickness of this alluvium is similar beneath Ponds A-1, A-2, and A-4. Colluvium is found on the slopes adjacent to the drainage area of North Walnut Creek. Well B208489 (Figure 2-2) located upstream from Pond A-1, encountered approximately 12 feet of colluvium. The Arapahoe Formation, specifically the Arapahoe No. 4 sandstone, is potentially the bedrock unit beneath the valley fill alluvium and colluvium in the immediate area of the A-series ponds (EG&G 1990e). A schematic cross section through North and South Walnut creeks, upgradient of the A-series and also the B-series Ponds, is illustrated in Figure 2-5 to show the general geology of the area. Figure 2-6 is a cross section illustrating a more detailed section beneath Ponds A-3 and A-4 (EG&G 1991a).

Descriptions of the geologic units found beneath and near the A-series Ponds, including the valley fill alluvium, colluvium, and the Arapahoe No. 4 sandstone interval, are discussed below. A discussion on the hydrogeology of the area is also presented.

<u>Valley Fill Alluvium and Colluvium</u> - The valley fill alluvium and colluvium are described together as their lithologies are similar. These units are yellowish-brown, silty gravelly clays to gravelly sandy clays with fine to coarse sands and quartzite gravels. The colluvium is deposited by slope wash and downslope

creep of the Rocky Flats Alluvium and the Arapahoe Formation. The valley fill alluvium is stream-deposited materials from the erosion of the Rocky Flats Alluvium, Arapahoe Formation and colluvium in this area.

Arapahoe Formation (No. 4 Sandstone Interval) - The Number 4 sandstone interval of the Arapahoe Formation is a stratigraphic unit comprised of fluvial overbank and channel sediments that underlies the valley fill alluvium, pond sediments, and colluvium in most of the pond area (EG&G 1990e). This sandstone unit, which is approximately 10 to 15 feet thick, is present in monitoring well 1186 indicating a sandstone channel may be present immediately beneath the A-series Ponds (Figure 2-6). Based on the lithology encountered in other nearby monitoring wells (wells 1286 and 1386), this unit is comprised of a silty clay beneath some of the ponds (Figure 2-2). This silty clay unit is believed to be a fluvial overbank deposit time-stratigraphically equivalent to the Number 4 channel sandstone.

The uppermost aquifer near the A-series Ponds is the valley fill alluvium. The saturated portion of the valley fill alluvium is generally less than 5 feet in thickness with groundwater encountered from 2½ to 5½ feet below the ground surface. Based on the lithology of the valley fill alluvium in monitoring wells 1286 and 1386, this unit probably has moderate permeability. Groundwater flow within the unit is downstream primarily to the east. Flow direction is probably modified, however, near each surface impoundment by recharge from each pond and by the removal of the alluvial sediments in this area during pond construction.

Beneath the valley fill alluvium, the Arapahoe Formation contains a high percentage of siltstone and claystone and is likely to have a lower permeability than the overlying alluvium. However, if the Arapahoe No. 4 sandstone is present, it would be expected to have a moderate permeability.

2.3 B-SERIES PONDS B-1, B-2, B-3, B-4, AND B-5 (IHSSs 142.5, 142.6, 142.7, 142.8, and 142.9)

2.3.1 Location and Description

Ponds B-1, B-2, B-3, B-4, and B-5 (IHSSs 142.5 through 142.9) are built in South Walnut Creek, east of the eastern perimeter of the security area of the Plant (Figure 2-7). The estimated capacity for Ponds B-1 through B-5 are 795,000; 1,930,000; 620,000; 600,000 and 23,140,000 gallons, respectively. The B-series Ponds were generally constructed by the placement of an earthen embankment across South Walnut Creek. Outlet structures and spillways were built in some of the ponds to regulate flow out of these detention ponds and to channel excess water around the embankments when the ponds are near their full capacity. As-built drawings were obtained for Pond B-5 and are contained in Appendix B (EG&G 1991c). A description of how these ponds interact with South Walnut Creek's surface water flow is contained in subsection 2.1.

2.3.2 History

The B-series Ponds are used primarily to capture and control surface water runoff from the eastern and central portions of the Rocky Flats production facilities. Historically, several waste disposal activities have been associated with the B-series Ponds since the beginning of the Plant operations in 1952. Between 1952 and 1973, decontaminated process water and laundry wastewater were released into South Walnut Creek and subsequently into the B-series Ponds (Ponds B-1 through B-4). Nitrate, plutonium, and uranium were contained in these wastes; however, the volume of wastes released into South Walnut Creek is unknown (Rockwell 1988). Ponds B-1 and B-4 also received sanitary effluent from the sewage treatment plant (U.S. DOE 1980).

Pond reconstruction activities between 1971 and 1973 resulted in disturbances of the bottom sediment. This construction caused much of the upstream sediment to migrate to the B-1 pond, which subsequently increased the total plutonium inventory in the entire B-series Ponds (U.S. DOE 1980). As a result of this activity, there are probably several additional curies of plutonium presently trapped in the sediment within the waste discharge pipe and the inlet of Pond B-1 (Rockwell 1988). Presently, Ponds B-1 and B-2 are used for spill control management and to detain local surface runoff and seepage which may occur from nearby areas. Pond B-3 receives effluent from the Sewage Treatment Plant (STP) (Building 995), local surface runoff, and intercepted groundwater from a seepage area near the solar evaporation ponds. Pond B-4 receives discharges from Pond B-3. The water in Pond B-4 is continuously released into Pond B-5.

Pond B-5 was constructed after 1979 and was used as an overflow pond for Pond B-4. Presently, Pond B-5 receives water from Pond B-4 and surface runoff from the Central Avenue Ditch. The water is detained and then pumped to Pond A-4, where it is treated by a granular activated carbon (GAC) system prior to being discharged downstream into Walnut Creek.

2.3.3 Surface Drainage

The surface drainage into and downstream from the B-series detention ponds (Ponds B-1 through B-5) is discussed in subsection 2.1. Ponds B-1 and B-2 receive local surface runoff and seepage which may occur near these ponds. Pond B-3 receives effluent from the STP, local surface runoff, and intercepted groundwater from the seepage area near the solar evaporation ponds (U.S. EPA 1984). Pond B-4 receives water from Pond B-3. The water in Pond B-4 is continuously released into Pond B-5. Pond B-5, in addition to receiving discharges from Pond B-4, receives surface runoff from the Central Avenue Ditch located south of the B-series Ponds.

2.3.4 Nature of Contamination and Previous Investigations

Various investigations of the water and sediment quality within the B-series Ponds and in South Walnut Creek drainage have been conducted. Included in these studies are a study conducted by EPA (U.S. EPA 1970), a 1980 study on plutonium in freshwater systems at Rocky Flats (Paine 1980), and a 1986 study conducted as a requirement for a RCRA Part B Permit Application (Rockwell 1988). In addition, analytical results from surface water samples taken in each pond during 1989 have been summarized as part of this work plan.

In the 1970 study conducted by EPA, a water sample and a bottom sediment sample were collected downstream from the B-series Ponds in South Walnut Creek (Figure 2-3). Grab samples of water were collected in 1-gallon plastic containers with 2 to 5 gallons collected per sample. Bottom sediment samples were collected by scraping the bottom area below the water line with a hand trowel. Analysis of this water and bottom sediment sample are presented in Table 2-5.

The 1980 study by D. Paine, was conducted in order to determine the behavior of plutonium in the freshwater systems at Rocky Flats (Paine 1980). In this study, sediment cores were taken at 5 cm intervals on a monthly basis from Ponds B-1, B-2, B-3 and B-4 between the spring of 1971 through the summer of 1973. These core samples were taken to determine vertical distribution of plutonium in the pond sediments. Surface water samples and water samples collected at depth (0.5 meter increments from the pond surface to the sediment water interface) were also collected.

The average or mean plutonium concentrations (Pu-239 and Pu-240) in unfiltered water samples and surface sediment samples from Ponds B-1 through B-4 for this study are illustrated in Figure 2-8. An accidental release of water containing low concentrations of Pu-239, -240 was released into the sanitary waste system in March 1971. This release is apparent in Figure 2-8. In addition, reconstruction activities of each of the ponds in 1972 also resulted in a significant increase in plutonium concentrations in the mean surface (top 5 cm) sediments of the ponds (Figure 2-8) (Table 2-6). Plutonium concentrations also increased in the sediment sample and unfiltered water sample collected at the sampling location at Walnut Creek and Indiana Street during this reconstruction period (Figure 2-9). This increase suggests that reconstruction played a role in redistributing plutonium in Walnut Creek. Also during this study, core samples of the sediments were collected from Ponds B-1 through B-4 and analyzed for plutonium at 5 cm intervals. The results from this sampling program indicated that the highest plutonium concentrations occurred in Pond B-1. Plutonium concentrations in ponds B-1, B-2, B-3 and B-4 as a function of sediment depth are illustrated in Table 2-7 (Paine 1980).

TABLE 2-5

DISSOLVED RADIOACTIVITY IN A WATER SAMPLE AND RADIOACTIVITY IN A BOTTOM SEDIMENT SAMPLE ALONG SOUTH WALNUT CREEK

	Strontium-90	Total Alpha Radiation	Total Uranium	Plutonium 239	Gross Alpha	Gross Beta
Water Sample [1]	0.6	0.1	7.9	0.04	N.D.	N.D.
Sediment Sample[2]	0.1	3.4	1.1	3.51	18.0	N.D.

Notes: [1] All units in pCi/l except for uranium (μg/l)
[2] All units in pCi/gram dry weight except for uranium (μg/gram)

N.D. - Not determined

Source: EPA 1970

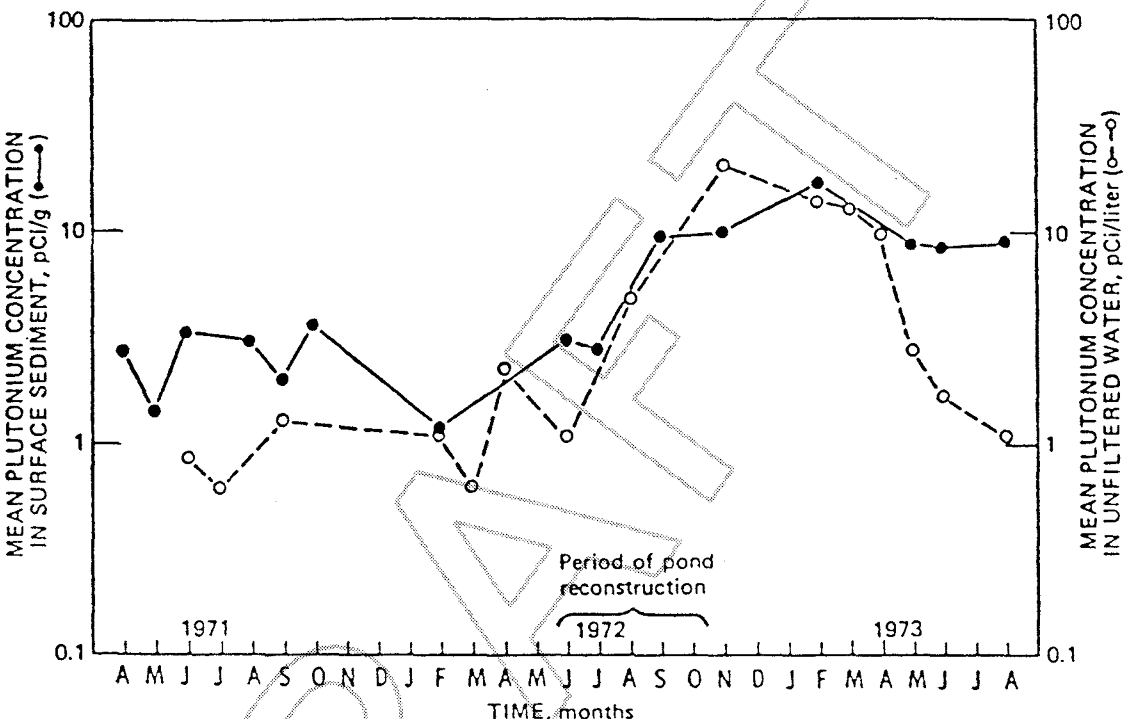
TABLE 2-6

MEAN-SURFACE (TOP 5 CM)-SEDIMENT PLUTONIUM 239/240 CONCENTRATIONS DURING PRECONSTRUCTION AND POSTCONSTRUCTION PERIODS

	Preconstruction		Postconstruction	
Pond	n*	pCi/g†	n*	pCi/g†
B-1	13	200 ± 70	11	1300 ± 350
B-2	12	80 ± 30	11	200 ± 60
B-3	13	30 ± 10	11	200 ± 200
B-4	14	20 ± 10	10	55 ± 15

*n = number of sampling periods
† = Mean ± standard error

Source: Paine 1980



SOURCE: PAINE, 1980

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MEAN PLUTONIUM CONCENTRATIONS IN SURFACE SEDIMENTS (pCi/g) AND MEAN PLUTONIUM CONCENTRATIONS IN UNFILTERED WATER (pCi/l) FOR THE SAMPLING STATION LOCATION WHERE WALNUT CREEK CROSSES UNDER INDIANA STREET

FIGURE 2-9 APRIL 1991

TABLE 2-7

DISTRIBUTION OF PLUTONIUM CONCENTRATIONS IN DEPTH PROFILES OF PONDS B-1 THROUGH B-4

	Plutonium concentration, $(d/min)g^{-1}$			
Depth, cm	Pond B-1	Pond B-2	Pond B-3	Pond B-4
0 - 5	2,000	260	40	430
5 - 10	2,200	80	170	190
10 - 15	10,900	40	370	20
15 - 20	32,100	60	330	4
20 - 25	8,800	230	20	7
25 - 30	1,100	190	3	7
30 - 35	880	390	3	<1
35 - 40	900	340	380	
40 - 45	190	100	6	
45 - 50	30	20	6	
50 - 55	100	10	3	
55 - 60	70	9	2	
60 - 65	5	4	2	
70 - 75	7	3		
75 - 80		2		
80 - 85		12		
85 - 90		50		
90 - 95		30		
95 - 100		3		
100 - 105		7		
105 - 110		40		
110 - 115		12		

Source: Paine 1980

The 1986 study "Trends in the Rocky Flats Surface Water Monitoring", summarized analytical data collected between 1980 and 1985. The water quality of Pond B-1 was characterized by low major ion concentrations and moderately elevated uranium-233/234 (6.4 pCi/l) and uranium-238 (9.6 pCi/l) concentrations. Plutonium concentrations were recorded at 4.2 pCi/l. In 1973, the plutonium inventory of the sediments in Pond B-1 was 2.9 Curies. Hazardous Substance List (HSL) organics were detected in these samples but were reported to be less than the detection limits (Rockwell 1988). Water in Pond B-2, unlike the water in Pond B-1, contained background levels for the various radionuclides, with the exception of plutonium (.37 pCi/l). Pond B-3 was characterized by relatively low major ion concentrations and background levels for the radionuclides with the exception of plutonium, at a concentration of 0.08 pCi/l. Zinc was moderately elevated (0.58 mg/l) and nitrate was present at 13.4 mg/l (Rockwell 1988). Water in Pond B-4, which receives surface water runoff and occasional flow from Pond B-3, had levels of uranium-233/234 at 1.5 pCi/l and uranium-238 at 2.1 pCi/l. Major ions were at relatively low concentrations and nitrates were undetected. Strontium and zinc occurred at 0.31 mg/l and 0.36 mg/l, respectively. Radionuclide data available from Pond B-5 showed slightly elevated concentrations of uranium-233/234 (2.6 pCi/l) and uranium-238 (2.1 pCi/l). All other radionuclides were at background levels (Rockwell 1988).

Analytical results from surface water samples collected during 1989 from each of the B-series Ponds (Ponds B-1 through B-5) were reviewed for this work plan to provide additional data on the ponds. A majority of these data have not yet been validated; therefore, there are some uncertainties in the unvalidated data. The maximum concentrations detected during 1989 for most analytes in each of the ponds have been tabulated in Table 2-8.

Discharges from Ponds B-3 and B-5 are regularly monitored to comply with NPDES permit requirements. Sanitary effluent limitations have been placed on Pond B-3 and sediment limitations have been placed on Pond B-5. All discharges are monitored for plutonium, americium, uranium, and tritium (Rockwell 1987a). Pond B-5 has a downstream 24-hour time-composite sampler and Parshall flume to monitor discharge. The data on water quality results from the discharge of this pond are recorded and presented in the Environmental Monitoring Report prepared by EG&G (EG&G 1990f). Continuous flow measurements and daily water quality samples are collected at Pond B-5.

2.3.5 Geology and Hydrology

The geologic units near and beneath the B-series Ponds and within the drainage area of South Walnut Creek include valley fill alluvium, colluvium, and the Arapahoe Formation. Two monitoring wells (well nos. 3686 and 3786), drilled adjacent to Ponds B-1 and B-5 in South Walnut Creek encountered approximately 5½ to 7 feet of valley fill alluvium (Figure 2-7). The valley fill alluvium is a yellowish-brown to light-gray sandy clay to clayey gravel unit. Beneath the valley fill alluvium is the Arapahoe Formation which is described as a yellowish-gray to light-olive gray claystone in the above wells.

TABLE 2-8

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED IN PONDS B-1, B-2, B-3, B-4, AND B-5 IN 1989

Analyte	Pond B-1 (SW-B1)	Pond B-2 (SW-B2)	Pond B-3 (SW-B3)	Pond B-4 (SW-B4)	Pond B-5 (SW-B5)
Radionuclides	Concentration[3] (pCi/l)	Concentration[3] (pCi/l)	Concentration[3] (pCi/l)	Concentration[3] (pCi/l)	Concentration[3] (pCi/l)
Americium-241	0.08 ± 0.02	0.07 ± 0.02	0.05 ± 0.01	0.02 ± 0.01	0.01 ± 0.02
Cesium-137	0.7 ± 0.6	0.3 ± 0.6	0.1 ± 0.6	0.3 ± 0.7	0.6 ± 0.5
Gross Alpha	5.0 ± 3.0	5.0 ± 4.0	3.0 ± 2.0	8.0 ± 4.0	5.0 ± 3.0
Gross Beta	9.0 ± 3.0	9.0 ± 3.0	13.0 ± 3.0	10.0 ± 3.0	10.0 ± 2.0
Plutonium-239	0.85 ± 0.05	0.27 ± 0.03	0.15 ± 0.03	0.02 ± 0.01	0.01 ± 0.01
Radium 226	0.3 ± 0.3	0.0 ± 0.3	--	0.4 ± 0.3	0.2 ± 0.3
Radium 228	--	--	--	--	--
Strontium 90	0.3 ± 0.4	0.7 ± 0.6	0.4 ± 0.4	1.3 ± 0.4	0.9 ± 0.4
Tritium	360.0 ± 220.0	270.0 ± 220.0	370.0 ± 220.0	310.0 ± 220.0	300.0 ± 200.0
Uranium Total[1]	6.3	4.2	0.2	7.8	4.6
U-233/234	3.2 ± 0.5	2.2 ± 0.4	0.2 ± 0.2	4.0 ± 0.5	2.8 ± 0.4
U-235	0.1 ± 0.1	0.1 ± 0.1	0.0 ± 0.1	0.2 ± 0.1	0.2 ± 0.01
U-238	3.0 ± 0.5	1.9 ± 0.4	0.0 ± 0.2	3.9 ± 0.5	2.4 ± 0.5
Metals	Concentration[3] (mg/l)	Concentration[3] (mg/l)	Concentration[3] (mg/l)	Concentration[3] (mg/l)	Concentration[3] (mg/l)
Iron	0.410	0.450	0.232	0.470	0.608
Magnesium	22.50	22.60	7.01	20.94[2]	11.60
Manganese	0.219	0.614	0.0318	0.300[2]	0.868
Mercury	0.0007	0.0004	0.0008	0.0066[2]	0.0010[2]
Selenium	0.0283	N.A.	N.A.	N.A.	0.0085
Strontium	0.496	0.336	N.A.	N.A.	0.323
Zinc	N.A.	1.01	0.123	0.491	0.310
Lead	N.A.	N.A.	N.A.	N.A.	0.0140
Beryllium	N.A.	N.A.	N.A.	N.A.	0.0095
Cadmium	N.A.	N.A.	N.A.	N.A.	0.0188
Organics	Concentration[3] (μg/l)	Concentration[3] (μg/l)	Concentration[3] (μg/l)	Concentration[3] (μg/l)	Concentration[3] (μg/l)
Phenol	39.0	2.0	2.0	2.0	5.0

Note: [1] No units are available
Note: [2] Concentration validated
Note: [3] Potential applicable or relevant and appropriate equirements for OU6 are presented in Section 3.0
N.A.: Not Analyzed
Source: EG&G 1990c

(see Figure 2-7 for Surface Sample Locations)

A schematic cross section across South Walnut Creek upgradient from the B-series Ponds is presented in Figure 2-5.

The uppermost aquifer near the B-series Ponds is the valley fill alluvium. Groundwater is encountered a few feet below the ground surface in this area, and groundwater flow is generally to the east. The flow through the valley fill alluvium probably has been modified near each surface impoundment by recharge from the pond and the possible removal of the alluvium during pond construction. The valley fill alluvium likely has moderate permeability, in comparison to the Arapahoe Formation which is primarily a claystone with a low permeability. Therefore, groundwater flow probably does not migrate through the Arapahoe Formation.

2.4 NORTH, SOUTH, AND POND AREA SPRAY FIELDS (IHSSs 167.1, 167.2, and 167.3)

2.4.1 Location and Description

IHSSs 167.1, 167.2, and 167.3 are located north of the security area of the Plant and north of North Walnut Creek (Figure 2-10). The North and South Area Spray Fields (IHSSs 167.1 and 167.3), which occupy approximately 172,500 and 40,000 square feet (3.96 and 0.92 acres), respectively, are partially located on the plateau areas that bound the unnamed tributary on North Walnut Creek. The Pond Area Spray Field (IHSS 167.2) occupies approximately 31,250 square feet (0.72 acres) and is located on a north-facing slope leading into the present-day Landfill Pond (Figure 2-10). These spray fields are presently covered by grasses common to the Rocky Flats Area.

2.4.2 History

The periods during which these IHSSs were operational are not precisely known; however, the spray fields were used shortly after the present landfill became active in 1968. These fields were used solely for the purpose of spraying water over the ground surface to enhance evaporation of the water. The water sprayed over these spray fields was obtained from two ponds located east of the Present Landfill (IHSS 114) (Figure 2-1). These two ponds, referred to as the East Landfill Pond (the existing landfill pond) and the West Landfill Pond (no longer present), were used to intercept groundwater that may have been contaminated by leachate generated at the landfill, and to impound leachate generated by the landfill, respectively (Figure 2-1). In addition, the East Pond was used for spill control management. In May 1981, with the expansion of the landfill (U.S. DOE 1990a), the West Pond was covered over.

Spray evaporation was selected as the method to dispose of water from these ponds. The first area used as a spray field was the South Area Spray Field (IHSS 167.3). During operation of this spray field, surface runoff was found to be draining toward North Walnut Creek. The use of this field was subsequently discontinued and the spray irrigation was moved to the North Area Spray Field (IHSS 167.1). During operation of this spray field, the water sprayed onto this unit was found to be draining into the unnamed tributary of North Walnut Creek and, subsequently, into Walnut Creek. The spraying was again discontinued and moved to the Pond Area Spray Field (IHSS 167.2). During operation of this spray field, the drainage from this unit flowed back into the existing landfill pond and thus water was continually contained within this pond.

2.4.3 Surface Drainage

Surface runoff across the North Area Spray Field (IHSS 167.1) and the South Area Spray Field (IHSS 167.3) flows toward the unnamed tributary of North Walnut Creek (Figure 2-6). Surface runoff across IHSS 167.2 flows to the north, where it enters into the present landfill pond.

2.4.4 Nature of Contamination and Previous Investigations

No previous studies have been conducted at these spray fields. However, there are some chemical analytical results from surface water samples collected from the West and East Landfill Ponds. These data are significant, since the water from the ponds was sprayed onto the spray fields.

In September 1973, tritium and strontium were detected in the drainage of the Rocky Flats Sanitary Landfill. Due to this discovery and since the two landfill ponds collected water and leachate generated from the landfill, samples from the two ponds were analyzed for these two analytes. Strontium concentrations for both landfill ponds were reported from 1973 until 1984 and are contained in Table 2-9 (Blaha 1987). In addition, between 1973 and 1980, monthly tritium concentrations were reported for the West Pond (no longer present) with the results tabulated in Table 2-10.

Analytical results from surface water samples collected at two nearby surface locations (SW-96 and SW-97) during 1989 were also reviewed as a part of this work plan. SW-96 and SW-97 are located downslope from IHSSs 167.1 and 167.2, respectively (Figure 2-10). These two locations are sampled on a monthly basis as a part of the surface water monitoring program being conducted at the Rocky Flats Plant. The maximum concentrations during 1989 for most analytes detected in the surface water samples collected at SW-96 and SW-97 are presented in Tables 2-11 and 2-12, respectively. In addition to these surface water data, analytical results from groundwater samples collected during 1989 from two monitoring wells (B206789 and B206689) located downslope from IHSSs 167.2 and 167.3, respectively, have been summarized in Table 2-13. A majority of these data have not yet been validated, therefore, there are some uncertainties in the unvalidated data.

TABLE 2-9

STRONTIUM CONCENTRATIONS IN LANDFILL PONDS

Month	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
January	N.A.	0.5	<3	3.5 E 7.5 W	3.6 E <3 W	N.A.	N.A.	N.A.	N.A.	--	--	N.A.
February	N.A.	<3	<3	<3 E <3 W	3.0 E 3.0 W	N.A. N.A.	N.A.	<3	N.A.	--	--	N.A.
March	2.3	<3	N.A.	3.2 E 3.2 W	4.6 E <3 W	N.A.	7.2	<3	<3	--	--	N.A.
April	N.A.	2.4	N.A.	N.A.	<3 E <3 W	N.A.	5.7	<3	<3	--	--	N.A.
May	N.A.	N.A.	<3	<3	3.5 E <3 W	N.A.	N.A.	<3	3.5	--	--	N.A.
June		N.A.	<3	4.2	4.3 E <3 W	N.A.	<3	<3	3.3	--	--	N.A.
July		N.A.	<3	<3	4.3 E <3 W	N.A.	3.3	<3	4	--	--	N.A.
August		N.A.	<3	<3	3.5 E 2.1 W	3.2 E	<3	<3	4.5	--	--	N.A.
September		N.A.	<3	<3	4.1 E 5.0 W	<3 E	N.A.	N.A.	3	--	--	N.A.
October		7.9	<3 3.4 W	<3 3.4 W	4.4 E <3 W	4.3 E <3 W	<3	N.A.	3	--	--	16
November		N.A.	<3	<3	3.6 E <3 W	5.8 E <3 W	3.6	N.A.	<10	--	--	16
December		N.A.	0.6	<3	3.7 E <3 W	45 E <3 W	N.A.	N.A.	NS	3	--	N.A.

NOTES: Results prior to April 1983 were Sr^{89} + Sr^{90} in most cases, except for 1973.
N.A. - Not Analyzed
E = East Landfill Pond
W = West Landfill Pond
EPA Drinking Water Standard: Sr^{89} = 80 pCi/l, Sr^{90} = 8pCi/l
All concentrations in pCi/l

Source: Blaha 1987

TABLE 2-10

TRITIUM CONCENTRATIONS IN WESTERN LANDFILL POND

Month	1980	1979	1978	1977	1976	1975	1974	1973
January	738	1316	1136	1365	1740	1143	N.A.	
February	709	780	1368	922	1733	1429	N.A.	
March	520	844	775	1303	1323	1837	7922	
April	886	886	944	1113	1431	924	N.A.	
May	639	805	956	818	1121	1445	N.A.	
June	530	816	720	740	1172	984	5875	
July	546	694	953	856	1378	1520	4797	
August	508	976	1022	983	1305	1258	3724	
September	576	564	768	863	1143	1777	5056	34,000 39,000 57,000
October	495	938	818	806	869	1762	3304	N.A.
November	490	575	1033	812	1005	1553	1800	N.A.
December	530	436	863	880	1067	1542	N.A.	N.A.

NOTES: Concentrations in pCi/l
N.A. - Not Analyzed

Source: Blaha 1987

TABLE 2-11

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED AT LOCATION SW-96 IN 1989

Analyte	SW-96		
Radionuclides	Concentration[3] (pCi/l)		
Americium-241	0.01	±	0.01
Cesium-137	0.4	±	0.7
Gross Alpha	2.0	±	3.0
Gross Beta	5.0	±	2.0
Plutonium-239	0.01	±	0.01
Strontium-90	0.7	±	0.3
Tritium	160.0	±	230.0
Uranium, Total[1]	2.5		
Uranium-233/234	1.4	±	0.3
Uranium-238	1.1	±	0.3
Uranium-235	0.1	±	0.1
Metals	Concentration[3] (mg/l)		
Iron	2.04		
Lead	0.0109		
Magnesium	7.68[2]		
Manganese	0.0297		
Mercury	0.0009		
Strontium	0.198		
Aluminum	2.18		
Zinc	0.0293		

Note: [1] No units are available
[2] Concentration validated
[3] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

Source: EG&G 1990c

TABLE 2-12

MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED AT LOCATION SW-97 IN 1989

Analyte	SW-97		
Radionuclides	Concentration[3] (pCi/l)		
Americium-241	0.0	±	0.1
Americium-241 (Filtered)	0.02	±	0.02
Cesium-137	0.3	±	0.6
Gross Alpha	40.0	±	39.0
Gross Alpha (Filtered)	1.0	±	13.0
Gross Beta	36.0	±	51.0
Gross Beta (Filtered)	11.0	±	7.0
Plutonium-239	0.067	±	0.34
Plutonium-239 (Filtered)	0.01	±	0.02
Strontium-90	2.21	±	0.73
Strontium-90 (Filtered)	0.9	±	0.5
Tritium	520.0	±	210.0
Tritium (Filtered)	---		
Uranium, Total	5.5	±	
Uranium-233/234	3.8	±	0.5
Uranium-233/234 (Filtered)	---		
Uranium-235	0.09	±	0.18
Uranium-235 (Filtered)	0.0	±	0.1
Uranium-238	1.7	±	0.3
Uranium-238 (Filtered)	0.1	±	0.1
Radium-226	6.6	±	0.7
Metals	Concentration[3] (mg/l)		
Aluminum	21.30		
Iron	84.30		
Lead	0.0373		
Lithium	0.0805		
Magnesium	46.80[2]		
Manganese	2.11		
Strontium	1.26		
Zinc	6.05[2]		
Chromium	0.0215		
Copper	0.0451		
Mercury	0.0003		

TABLE 2-12
MAXIMUM CONCENTRATIONS DETECTED IN SURFACE WATER SAMPLES COLLECTED AT LOCATION SW-97 IN 1989
(Concluded)

Analyte	SW-97
Organics	Concentration[3] (µg/l)
2-Methylnapthalene	15.0
4-Methylphenol	29.0
Acenaphthene	2.0
Bis (2-Ethylhexyl) Phthalate	5.0
Napthalene	10.0
Phenanthrene	2.0
Phenol	2.0
2,4-Dimethyphenol	2.0
Benzoic Acid	6.0
Benzyl Alcohol	2.0
Di-n-Butyl Phthalate	1.0
Diethyl Phthalate	4.0
Fluorene	1.0

Note: [1] No units available
[2] Concentration validated
[3] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

Source: EG&G 1990c

TABLE 2-13

MAXIMUM CONCENTRATIONS DETECTED IN GROUNDWATER SAMPLES COLLECTED FROM WELLS B206689 AND B206789 IN 1989

Analyte	Concentration					
	Well B206689			Well B206789		
Radionuclide	Concentration[1] (pCi/l)			Concentration[1] (pCi/l)		
Cesium-137	0.54	±	.50	0.30	±	0.49
Gross Alpha	1.6	±	0.7	1.8	±	1.0
Gross Beta	2.70	±	1.8	2.8	±	1.9
Plutonium-239	0.015	±	0.008	0.011	±	0.007
Strontium-90	0.21	±	0.35	N.A.		
Uranium-235	0.26	±	0.30	0.20	±	0.41
Uranium-238	0.43	±	0.45	1.42	±	1.07
Tritium	N.A.	±		50.0	±	240.0
Metals	Concentration[1] (mg/l)			Concentration[1] (mg/l)		
Lithium	N.A.			0.200		
Magnesium	N.A.			36.40		
Selenium	N.A.			0.432		
Strontium	N.A.			1.20		
Zinc	N.A.			0.123		

Notes: N.A. = Not Analyzed
[1] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

Source: EG&G 1990c

2.4.5 Geology and Hydrology

The geology near and beneath these spray fields has been characterized from lithologic information obtained from the limited nearby monitoring wells and by the general knowledge of the geology of the area. The Rocky Flats Alluvium, colluvium and the Arapahoe Formation are the geologic units which underlie these IHSSs.

The Rocky Flats Alluvium is the surficial geologic unit underlying the western half of IHSS 167.1 and IHSS 167.3 (Figure 1-5). The Rocky Flats Alluvium is described as a poorly sorted, gravelly sandy clay to gravelly clayey sand, with subangular grains and scattered cobbles.

Colluvium is likely to be present beneath the eastern half of IHSSs 167.1 and 167.3 based on the lithology of monitoring well B206689 located slightly downslope from IHSS 167.3 (Figure 2-10). The colluvium is approximately 3 feet thick and is described as a silty sandy gravel to gravel containing cobbles and clay.

Fill and possibly colluvial deposits underlie the Pond Area Spray Field (IHSS 167.2). This is based on the lithologic units encountered in well B206789 located 10 feet downslope from this IHSS (Figure 2-10). Approximately 5 feet of fill was encountered overlying the Arapahoe Formation. The fill in this area is described as a consolidated, poorly sorted, brownish-gray sandy clay unit with angular to subangular sand.

The Arapahoe Formation underlies the Rocky Flats Alluvium, colluvium and fill in this area. This formation is described in nearby monitoring wells as a silty claystone to claystone, mottled, with very fine- to fine-grained sand. The Arapahoe Formation is found at a depth of approximately 4 to 6 feet below ground surface, and is highly weathered near the top of the unit.

Groundwater flow is toward the surrounding drainages and is discharged from the Rocky Flats Alluvium at the contact with claystones of the Arapahoe. The depth to groundwater under the spray fields is, however, unknown.

2.5 EAST AREA SPRAY FIELD (IHSS 216.1)

2.5.1 Location and Description

The East Area Spray Field (IHSS 216.1) is located within the buffer zone, northeast of the northeastern boundary of the security area of the Plant facility (Figure 2-1). It is geographically on an east-west trending interfluve that separates North and South Walnut creeks in the vicinity of the A-series and

B-series Detention Ponds (Figure 2-7). This IHSS covers an area of approximately 150,000 square feet (3.4 acres).

2.5.2 History

This spray field became operational in 1989 to provide an additional area to accommodate the spray evaporation of water in Pond B-3. The water in Pond B-3 is from the effluent of the Sewage Treatment Plant (STP) (Building 995), local surface runoff, and intercepted groundwater from a seepage area near the solar evaporation ponds (Figure 2-1) (U.S. EPA 1984). The use of this area as a spray field stopped shortly after it became operational in the latter part of 1989 due to excessive runoff problems.

2.5.3 Surface Drainage

Surface runoff across IHSS 216.1 is primarily to the south, where water flows toward South Walnut Creek. South Walnut Creek is about 80 feet lower in elevation than the East Area Spray Field and is approximately 500 feet away.

2.5.4 Nature of Contamination and Previous Investigation

No previous investigations have been conducted on this IHSS, however, maximum concentrations of most analytes tested from surface water samples collected from Pond B-3 during 1989, when this water was being sprayed upon this IHSS, have been tabulated in Table 2-8. These data provide information on the quality of the water sprayed on the East Area Spray Field. Most of these analytical data from Pond B-3 (Table 2-8) have not yet been validated, therefore, there are some uncertainties in the unvalidated data.

2.5.5 Geology and Hydrology

The geology beneath this IHSS is somewhat unknown as no monitoring wells have been drilled on this IHSS. Therefore, the geology beneath the East Area Spray Field has been characterized by the geographic location of this IHSS and from the surficial geologic map of the OU6 area (Figure 1-5). The Rocky Flats Alluvium, typical to plateau areas at Rocky Flats Plant, is the surficial geologic unit beneath this IHSS. The Rocky Flats Alluvium is estimated to be 5 to 10 feet in thickness based on outcrops that surround this IHSS. In this area, the Rocky Flats Alluvium is a poorly sorted, unconsolidated, gravelly silty sand unit with fine- to very coarse grained sand. Beneath the alluvium is the Arapahoe Formation. This unit is weathered near the top and consists of claystone with some interbedded sandstone units. Further characterization of the lithologic nature and thickness of these formations is needed.

Groundwater flow beneath this site is unknown. If groundwater is present, however, it probably flows to the northeast where it enters into either the North or South Walnut creek drainages.

2.6 TRENCHES A, B, AND C (IHSS 166.1, 166.2, and 166.3)

2.6.1 Location and Description

IHSSs 166.1, 166.2, and 166.3 are located north of the Rocky Flats security area on a plateau that separates North Walnut Creek and its unnamed tributary (Figure 2-10). IHSS 166.1 (Trench A) is estimated to have dimensions of approximately 40 feet by 190 feet and is located about 100 feet southeast of the present landfill. IHSS 166.2 (Trench B) is also estimated to be a 40-foot by 190-foot trench that is approximately 125 feet south of IHSS 166.1. IHSS 166.3 (Trench C) consists of two separate trenches (Figure 2-10). The first trench is located between IHSS 166.1 and IHSS 166.2 and is approximately 30 feet by 200 feet. The second trench is located about 300 feet east of IHSS 166.1 and is estimated to have dimensions of 20 feet by 100 feet.

2.6.2 History

The history of these IHSSs and the dates they were active are based primarily on aerial photographs (U.S. EPA 1988b), since little documentation is available concerning their operational histories. IHSS 166.1 (Trench A) appeared to be active from 1964 until about 1974 (Rockwell 1988). IHSS 166.2 (Trench B) was active in 1959, though the closure date of this trench is unknown. Evidence of this trench was still visible in the 1988 aerial photograph, after which time this area began to revegetate. IHSS 166.3 (Trench C) was active between 1964 until possibly 1974 (U.S. DOE 1986b). In 1978, a road had been built across a portion of IHSSs 166.1 and 166.3.

IHSSs 166.1 and 166.2 received uranium- and/or plutonium-contaminated sludge from the Sewage Treatment Plant (Building 995) (Rockwell 1988). No other materials or wastes are known to have been placed in these trenches. Materials placed in IHSS 166.3 are unknown, but it is probable that sewage sludge was also placed within this trench.

2.6.3 Surface Drainage

Surface runoff across these IHSSs is minimal as these surface trenches are located on a relatively flat area. However, surface runoff is toward the north, where it enters into either the existing landfill pond or the unnamed tributary of North Walnut Creek (Figure 2-10).

2.6.4 Nature of Contamination and Previous Investigations

Only one previous investigation of this site has been performed. In this investigation, soil samples were collected (date unknown) from IHSS 166.1 (Rockwell 1988). Laboratory results from these samples reported relatively low concentrations of uranium-233/234 (0.87 ± 0.16 pCi/l) and uranium-238 (0.79 ± 0.16 pCi/l). Volatile organics (2-butanol, 1,1,1-TCA, TCE, and toluene) were also detected, but concentrations are unavailable (Rockwell 1988).

2.6.5 Geology and Hydrology

The geology beneath these trenches has been based primarily on the lithology encountered in monitoring well B206489, drilled near IHSS 166.1 (Trench A)(Figure 2-10). Approximately 1.5 feet of topsoil has developed on the Rocky Flats Alluvium at IHSS 166.1 and may be present in the vicinity of Trenches B and C. Rocky Flats Alluvium is found beneath the topsoil and has a thickness of about 6 feet in this area. The Rocky Flats Alluvium is described as a poorly sorted, moderately cemented, sand and gravel unit, with angular to subangular grains and very fine- to very coarse-grained sands. The Arapahoe Formation underlies the Rocky Flats Alluvium, and is principally a claystone in this area. The thickness of this formation in this area is not known as no wells have penetrated through this formation.

The aquifer near these trenches is Rocky Flats Alluvium. Groundwater is approximately 5½ feet below ground surface and flow is primarily to the east. The permeability of the Rocky Flats Alluvium is likely to be high when compared to that of the Arapahoe Formation, which is primarily a claystone in this area, however, further characterization of these two formations is needed.

2.7 SLUDGE DISPERSAL AREA (IHSS 141)

2.7.1 Location and Description

The Sludge Dispersal Area (IHSS 141) is located along the eastern perimeter of the security zone of the Rocky Flats Plant facility. The western half of this IHSS is located within the security area of the Plant and the eastern half is located within the buffer zone (Figure 2-11). Located on the western half of this IHSS are two corrugated metal buildings which cover the present day drying beds of the Sewage Treatment Plant. The eastern half of this IHSS gently slopes eastward toward South Walnut Creek and the B-series Ponds. Two paved roads cross this IHSS in a north-south direction. One of the roads is within the security area while the other is located in the buffer zone. A drainage ditch separates these two roads, with the ditch being located on the outside of the security fence. The water which collects in this drainage ditch flows out and into the B-series Detention Ponds.

2.7.2 History

Prior to 1983, the Sludge Dispersal Area was an area that received airborne radioactive particles from dried sludge packaging operations (Rockwell 1988). The sludge was generated by the sewage treatment facility (Building 995) located near the western perimeter of this IHSS. In addition, this area may have received spillage of dried or drying sludge from drying beds visible in a 1964 aerial photograph (U.S. EPA 1988c), located to the west of this IHSS.

Radioactive laundry effluent was the only known radioactive effluent entering the drying beds between 1969 and 1972. By the latter half of 1972, however, plumbing changes were made and all Plant wastes were channeled through the Sewage Treatment Plant and then into the drying beds. This resulted in increased radioactivity levels in the sludges (Owen 1973). An overflow incident in June 1972 from Building 701 contributed elevated levels of plutonium to the effluent entering the Sewage Treatment Plant, and subsequently to the drying beds (Owen 1973).

2.7.3 Surface Drainage

Surface runoff across this IHSS drains into South Walnut Creek and subsequently into Detention Pond B-1. Pond B-1 is located about 300 feet to the east and is approximately 60 feet lower in elevation than the Sludge Dispersal Area.

2.7.4 Nature of Contamination and Previous Investigations

Prior to 1983, all Plant wastes were processed at the Sewage Treatment Plant; therefore, a potential for contamination within the drying beds by a variety of chemicals, particularly plutonium, is possible. However, no previous investigations have been conducted on this IHSS.

2.7.5 Geology and Hydrology

The geology beneath this IHSS has been characterized by the lithology encountered in a nearby monitoring well, P213889, located approximately 300 feet west of this IHSS (Figure 2-11). The Rocky Flats Alluvium is the surficial geologic unit underlying this IHSS. This alluvium is approximately 5 feet thick. The Rocky Flats Alluvium is described as a poorly sorted, unconsolidated, gravelly silty sand with subangular grains. Fine- to very coarse-grained sands and quartzites are also present with the lithology of the unit becoming more clayey near its base. Beneath the Rocky Flats Alluvium is the Arapahoe Formation, and potentially the Arapahoe No. 1 sandstone unit (EG&G 1990e). The No. 1 Arapahoe sandstone unit as encountered in well P213889, is described as a poorly sorted, nonstratified , light-gray unit that is stained dark yellowish-orange and has very fine- to trace medium-grained subangular sand grains. This unit is approximately 3½ feet thick. Below this sandstone unit, the lithology of the

Arapahoe Formation is a clayey sandstone unit. The uppermost section of the Arapahoe Formation is highly weathered and moist. The lithologic nature of the Arapahoe Formation beneath the Sludge Dispersal Area, however, is not fully known as no wells have been drilled on this IHSS to determine if the No. 1 Arapahoe sandstone encountered in the nearby monitoring well (P213889) is also present beneath the Sludge Dispersal Area.

The upper aquifer near and beneath the Sludge Dispersal Area is the Rocky Flats Alluvium. The Rocky Flats Alluvium beneath this site is moderately permeable based on the Alluvium's lithologic characteristics. Groundwater flow is to the east and the depth to groundwater is approximately 3 feet in this area. Downward migration of groundwater from the Rocky Flats Alluvium into the Arapahoe Formation in the vicinity of the Sludge Dispersal Area may occur if the lithology of the Arapahoe Formation is a sandstone. However, further characterization of the subsurface formations beneath this IHSS is needed.

2.8 TRIANGLE AREA (IHSS 165)

2.8.1 Location and Description

The Triangle Area is located within the security area of the Rocky Flats Plant facility between the NE Perimeter Road on the north and Spruce Avenue on the south (Figure 2-11). This IHSS covers approximately 250,000 square feet (5.7 acres). The western two-thirds of this unit are within the PSZ. The PSZ fencing crosses through the eastern one-third of this IHSS in a north-south direction (Figure 2-11). The Triangle Area is not paved, is sparsely vegetated, and has been partially covered with gravel fill, thickness unknown. The Triangle Area is presently used as a storage yard for various types of equipment and pipes. The southwestern corner of this IHSS overlaps slightly with IHSS 176 of Operable Unit No. 10.

2.8.2 History

The Triangle Area was used as a storage site for miscellaneous wastes between 1966 and 1975. During the latter half of 1966 the Triangle Area was first used as a drum storage area when it became necessary to remove a large number of drums to the Triangle Area from a field north of Building 883. This was due to construction activities of a new decontamination facility in that area. The drums were directly placed on the ground through the winter of 1966. In the spring of 1967, the Chemical Operations Department at Rocky Flats categorized all drums based on their contents and placed them on wooden pallets (DOW 1974a). Various scrap materials stored in the drums included graphite molds, crucibles, incinerator ash heels, crucible heels, Raschig Rings and combustible wastes (DOW 1974b). These scrap materials were stored until they could be processed for plutonium in Building 771. Drums containing graphite and washables were also found stored in the Triangle Area in March 1967. Surfaces of surplus equipment stored in the area during this time had detectable concentrations of alpha contamination, apparently blown from the nitrate ponds or solar evaporation ponds to the west (DOW 1974a). By December 1968, about 5,000 drums had been placed on the Triangle Area. High winds during December 1968 were responsible for damaging many drums located on the Triangle Area. One incident that was reported indicated that as many as 150 drums had blown over at one time (DOW 1974a). The type of drums and liners used for the storage of wastes in the Triangle Area varied. Until 1969, the 55 gallon drums used for containment of wastes were made of an inexpensive material, had a liner made of double polyethylene bags, and had previously been used to contain miscellaneous wastes. During 1969, the Chemical Operations group started cutting lids from peroxide container liners, and these were used as inside liners for the drums. By 1971, the use of used drums was discontinued due to several spills and leaks which had resulted from drum deterioration. Better quality drums were purchased and used only once (DOW 1974a).

In May 1969, a fire occurred in Building 776. Following cleanup operations, the accumulated fire waste and residues from the fire were drummed and moved into the Triangle Area for temporary storage until they could be sent to the drum counter in Building 771. The amount of plutonium contained in the wastes was estimated to determine whether the wastes would be shipped to the Idaho facility or held in the Triangle Area until the waste could be processed for the recovery of plutonium (DOW 1974a).

On five separate occasions, once in 1969, once in 1971, and three times in 1973, leaking drums were discovered on the site. A historical summation of each incident is provided below.

In January 1969, approximately 29 drums were found leaking on the Triangle Area. This leakage affected an area of about 200 square feet (Owen 1973). The soil was subsequently removed and shipped as hot waste to an off-site facility (DOW 1974a). Following this 1969 spill, all the drums in the Triangle Area were transferred to rail/truck cargo containers to help minimize future leakage that might occur. This transfer was completed by 1971 (DOW 1974a).

Leaking drums were again discovered on site in 1971, in spite of the efforts to contain all wastes in better quality drums and in the cargo containers. Contaminated soil was removed from approximately 1,000 square feet of the Triangle Area as a result of this incident. Wastes contained in the leaking drums within the cargo containers apparently included incinerator ash heels and Fulflo filters (Owen 1973). Insufficient drying of the incinerator ash heels and Fulflo filters may have contributed to the deterioration of the drums. This may have resulted in the accumulation of dilute nitric acid, which eventually penetrated the bottom of the drums. Condensation of moisture during periods of cold weather may also have contributed to liquid accumulation within the drums and eventually penetration of the wastes through the bottom of the drums (DOW 1974c). After the 1971 incident, the bottom of the cargo containers were routinely fiberglassed on the inside with fiberglass running up approximately one inch on each of the four inner walls. This addition was to enhance and improve containment of the waste and any moisture buildup within the cargo containers (DOW 1974a).

In June 1973, a spill from a leaking drum containing nitric acid was found. This spill affected an area of approximately 500 square feet. Approximately 40 drums of soil were removed for off-site disposal (Rockwell 1988). A second incident in the summer of 1973 occurred when leakage from the contents of two drums in a cargo container was discovered. Holes, about one and one-half inch in diameter, were found at the bottom of the drums. These drums contained incinerator ash heels (DOW 1974a). The two soil contaminated areas were treated with a strippable coating (latex in one case and plastic foam in the second) to prevent resuspension of the waste in air. This strippable coating, along with the contaminated soil, were subsequently removed and shipped to an Idaho facility as non-retrievable hot waste (DOW 1974b). In late 1973, a third area found to be contaminated was temporarily covered with latex to protect the area from high winds during the winter of 1973. In August 1974, eight drums of both soil and latex were removed from this area (DOW 1974b).

In September/October 1974, an initial radiometric survey of the Triangle Area identified 26 spots above background. Three soil survey instruments were used in this investigation and were a Spark V, FIDLER, and Ludlum 12 instrument. A description of each of these instruments along with the original draft report from these surveys are contained in Appendix C of this work plan.

Following this initial survey, several additional radiometric surveys were conducted on portions of the Triangle Area during the first half of 1975. These surveys were conducted with a Spark V instrument. Included in these surveys were surveys conducted over an area of 1,000 square feet in January (DOW 1975a), 2,000 square feet in February (DOW 1975b), 1,337 square feet in March (DOW 1975c), 3,000 square feet in April (DOW 1975d), and 3,500 square feet in May (DOW 1975e). In all cases, no additional hot spots were discovered on the Triangle Area. Locations where the surveys were conducted on the Triangle Area are not known.

By June 1975, all cargo containers were removed from the Triangle Area and shipped to an approved facility in Idaho. This area has not been used since for radioactive storage (Rockwell 1988). Following the removal of the cargo containers, a radiometric soil survey was conducted over an area of approximately 4,000 square feet on the Triangle Area. No hot spots were identified from the survey; however, six drums of soil from previously discovered hot spots were removed and sent to the drum counter at Building 771 (DOW 1975f). A second radiometric survey was conducted on the Triangle Area in July 1975 in an area of approximately 2,000 square feet. Two very small hot spots were detected, but no soil was removed from these areas at this time (Rockwell 1975).

In a letter dated July 13, 1979, from Rockwell International to DOE, the results from a radiometric soil survey conducted within the PSZ and specifically the Triangle Area were presented. Four areas within the Triangle Area were recorded to have above-background readings at this time (Rockwell 1979). By January 1980, the soil in these designated areas had been removed (Rockwell 1980). The locations of these excavated areas are shown in Figure 2-11. The amount of soil removed from these areas is unknown.

A preliminary review of aerial photographs for this work plan revealed that in addition to the 55-gallon drums stored on this IHSS, miscellaneous equipment was also present on the west and northwest part of this IHSS between 1971 and 1983. Stained soils were visible in the northwest corner of this unit in the 1971 aerial photograph (U.S. EPA 1988b). In the 1986 aerial photograph, the Triangle Area had a minimal amount of material, such as pipes and scrap metal, stored on its premises.

2.8.3 Surface Drainage

Surface runoff across this IHSS is minimal as this unit is located on a relatively flat area. However, runoff from the Triangle Area flows towards the north and south, draining into North and South Walnut creeks via culverts.

2.8.4 Nature of Contamination and Previous Investigations

As described above in the history of the Triangle Area (Section 2.8.2), several soil investigations took place between 1969 and 1980 and soil was removed on several occasions from the area. In January 1969, due to the discovery of 29 leaking drums on the Triangle Area, radiation levels were detected as high as 200,000 dpm/100 cm^2 in adjacent soils (Rockwell 1988). In 1971, leaking drums containing incinerator ash heels, Fulflo filters and other miscellaneous waste resulted in levels ranging between 2,000 to 200,000 dpm/100 cm^2 in nearby soils (Rockwell 1988). In June 1973, an incident from a leaking drum containing nitric acid resulted in radiation levels of approximately 2,500 dpm/100 cm^2 in nearby and adjacent soils (Rockwell 1988). After soil removal had been completed from this nitric acid spill, a soil sample was collected from the base of the excavation to confirm that the cleanup had been adequately performed. This sample had a concentration of 24 dpm/g (Rockwell 1988).

In June 1975, following the removal of all cargo containers on the Triangle Area, six drums of soil from previously discovered hot spots were removed. Measurements indicated that the contents of five of the drums contained less than 1 gram of plutonium each while the sixth drum contained approximately two grams of plutonium (DOW 1975f).

Radiological surveys conducted in 1975 and 1979/1980 within the Triangle Area resulted in soil being removed and drummed for disposal. Soil was removed when surface counts were detected at 1,000 cpm or greater (Rockwell 1988). All areas reported at or above this level were cleaned up to a level of 250 cpm, as determined by a FIDLER probe (Rockwell 1988).

In addition to the above soil investigations, groundwater samples collected during 1989 from two alluvial groundwater wells (0460 and P209789) located in the western half of IHSS 165 (Figure 2-11) have been summarized as part of this work plan (Tables 2-14 and 2-15). Cuttings from well P209789 collected during drilling operations in 1989 were also analyzed and these results are tabulated in Table 2-16.

A majority of these data have not yet been validated and there are uncertainties in the unvalidated data.

2.8.5 Geology and Hydrology

The geology beneath the Triangle Area has been characterized by several alluvial and bedrock monitoring wells drilled in and adjacent to this IHSS (Figure 2-11). Well data for these wells can be found in Table 2-1. In addition, the draft geologic characterization report was used to further characterize this area (EG&G 1990e). Beneath and adjacent to the Triangle Area, the Rocky Flats Alluvium is the surficial geologic unit. The thickness of the alluvium beneath this site ranges from approximately 8½ feet, as encountered in well 2986, to approximately 12 feet as encountered in wells P209689, P209789 and P218389 (Figure 2-11). The Rocky Flats Alluvium is described as a yellowish-gray to reddish-brown, poorly sorted, silty clayey sand to sandy gravelly clay unit containing subrounded, coarse- to very-fine- grained sands and gravels. The Rocky Flats Alluvium thins to about 4 feet, approximately 200 feet northwest of the Triangle Area. This is based on the thickness of the Rocky Flats Alluvium in monitoring wells P208889 and P209589. South of this IHSS, the Rocky Flats Alluvium thickens to 22.5 and 25 feet as encountered in wells P219489 and P219589, respectively (Figure 2-11).

The Arapahoe Formation underlies the Rocky Flats Alluvium. The lithologic nature of the Arapahoe Formation beneath the western boundary of the Triangle Area is described as a yellowish-gray to light olive gray consolidated silty claystone based on surrounding monitoring wells. In addition, this unit is highly calcareous and is weathered near its top. In alluvial monitoring well 2986 (Figure 2-11) a sandstone unit approximately 10 feet thick was encountered in the Arapahoe Formation. This sandstone has been correlated and mapped as the Arapahoe Number 1 Sandstone (EG&G 1990e). The extent of this sandstone unit beneath the Triangle Area, however, is unknown and further characterization of this formation is needed.

TABLE 2-14

MAXIMUM CONCENTRATIONS DETECTED IN GROUNDWATER SAMPLES COLLECTED FROM WELL 0460 IN 1989

Analyte	Well 0460		
Radionuclides	Concentration[1] (pCi/l)		
Americium	0.0	±	0.005
Cesium-137	0.0	±	0.2
Gross Alpha	20.0	±	9.0
Gross Beta	42.0	±	7.0
Tritium	980.0	±	130.0
Plutonium-239	0.016	±	0.008
Uranium-235	0.7	±	0.4
Uranium-238	6.8	±	0.8
Strontium-90	0.08	±	0.12
Metals	Concentration[1] (mg/l)		
Magnesium	34.90		
Strontium	0.903		
Zinc	0.235		

Note: [1] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

Source: EG&G 1990c

TABLE 2-15

MAXIMUM CONCENTRATIONS DETECTED IN GROUNDWATER SAMPLES COLLECTED FROM WELL P209789

Analyte	Well P209789		
Radionuclides	Concentration (pCi/l)		
Americium 241	0.44	±	0.024
Gross Alpha	6.3		
Gross Beta	7.1		
Plutonium	0.018	±	0.016
Radium 226	0.86	±	0.11
Strontium 90	0.48	±	0.33
Tritium	350.0	±	260.0
Uranium 235	0.26	±	0.12
Uranium 238	2.52	±	0.38
Metals	Concentration[1] (pCi/l)		
Magnesium	27.0		
Selenium	0.0061		
Zinc	0.0684		

Note: [1] Potential applicable or relevant and appropriate requirements for OU6 are presented in Section 3.0

Source: EG&G 1990c

TABLE 2-16

MAXIMUM CONCENTRATIONS DETECTED IN DRILL CUTTINGS FROM MONITORING WELL P209789 WITHIN THE TRIANGLE AREA

Analyte	Well P209789		
Radionuclides	Concentration (pCi/g)		
Gross Alpha	25.0	±	10.0
Gross Beta	28.0	±	6.0
Plutonium-239	0.03	±	0.02
Radium-226	0.9	±	0.1
Radium-228	1.5	±	0.2
Uranium-233/234	0.7	±	0.2
Uranium-235	0.1	±	0.1
Uranium-238	0.9	±	0.2
Tritium[1]	1.6	±	0.2
Cesium-137	0.0	±	0.1
Metals	Concentration (μg/g)		
Aluminum	7,800.0		
Arsenic	2.2		
Barium	69.4		
Beryllium	2.2		
Calcium	17,800.0		
Chromium	8.8		
Iron	6,070.0		
Lead	86.9		
Lithium	8.9		
Magnesium	3,260.0		
Manganese	80.6		
Mercury	0.32		
Molybdenum	7.0		
Anions	Concentration (mg/kg)		
Nitrate[2]	53.1		
Nitrate/Nitrite	12.0		

Note: [1] Concentration in pCi/ml
[2] No units

Source: EG&G 1990c

The upper aquifer near and beneath the Triangle Area is the Rocky Flats Alluvium. Groundwater is approximately 3 feet below ground surface in this area. Beneath the northern part of the Triangle Area, groundwater probably flows toward the north into North Walnut Creek. Based on the topography in the southeast part of the Triangle Area, it is estimated that groundwater flows to the east toward South Walnut Creek.

2.9 OLD OUTFALL (IHSS 143)

2.9.1 Location and Description

The Old Outfall (IHSS 143) was located to the northwest of Building 773 (Guard Station) and Building 771 within the PSZ (Figure 2-12). This unit is approximately 30,000 square feet, and has been covered with fill (amount unknown). Temporary trailers are currently situated on and near this IHSS. Because of the construction activities in this area, the existing drainage system is different from the drainage system that existed during the operation of the outfall (Figure 2-13).

2.9.2 History

The Old Outfall acted as a catchment basin that received liquids from various sources, the main one being the laundry holding tanks in Building 771 (DOW 1971a). Liquid waste from these holding tanks, which contained plutonium, were discharged onto the outfall area if plutonium concentrations were found to be below 3,300 d/m/l. Between the middle of 1953 until mid-1957, 4.5 million gallons of liquid were released onto the Old Outfall. Approximately 2.23 mCi of plutonium were released with these liquids (DOW 1971a). At no time did concentrations from the discharge exceed 1,000 d/m/l (DOW 1971a). In 1957, a waste line was completed to allow liquid from these holding tanks to flow to Building 774. However, periodic releases from these holding tanks occurred between 1957 and 1965 onto the Old Outfall area and subsequently into North Walnut Creek due to occasional equipment problems. During this period, 434,000 gallons of liquid containing 0.25 mCi of plutonium were released to the outfall area (DOW 1971a).

Other sources of discharge to the Old Outfall area from building 771 included the analytical laboratory and radiography sinks, the personnel decontamination room (showers), and runoff from the roof and adjacent ground areas around the building. No documentation of the quantities of liquid or radioactivity content of these liquids was recorded (DOW 1971a).

The plutonium contamination contained in these discharges resulted in soil contamination at the point of discharge at the Old Outfall (DOW 1973). The first occurrence of soil contamination at the Old Outfall was reported in May 1956. Two years later, in May 1958, soil contamination was again found (DOW 1971a). It is not known if these contaminated soils were removed from this area.

In May 1968, a sewer line broke at Building 771. This incident caused the sewage lift station tank (located to the west of Building 771) to overflow onto the Outfall Area (Figure 2-13). Low concentrations of radioactive materials (including plutonium) and various chemicals were detected in the soils near the outfall following this spill (Rockwell 1988). In April 1970, hot spots were detected in the soils at the Outfall and subsequently soil samples were collected and analyzed. In June 1970, the area between building 771, the Old Outfall and North Walnut Creek was surveyed and in September contaminated soil was removed from an area of approximately 75 square feet in size (location unknown) (DOW 1971b).

In early 1971, an alpha survey along with soil sampling at the Old Outfall Area disclosed that an area of approximately 800 square feet was contaminated with plutonium. One small area showed contamination at a depth of 3½ feet (DOW 1971c). Removal of soils from an 800 square foot area at the Old Outfall began in February 1971 and was completed in early August (Figure 2-13). Soil was initially removed from an area 2½ feet deep, 3 feet wide and 15 feet long. The depth of this excavation became shallower (to a depth of about 1 foot) in the area farthest from the discharge point. East of this excavation, a second area, approximately 25 x 30 feet, was excavated to a depth of approximately 1 foot (DOW 1971a). Digging was performed only when the soils were relatively dry to reduce the potential for liquid to collect in the waste drums. Cement was added to each drum before and after the placement of the soil into the drums to absorb any liquid that may have been contained within the soil. The excavated area and the soil sample results from this area is illustrated in Figure 2-13 (DOW 1971c). Following these soil removal activities, the area was considered to be free of significant plutonium concentrations (DOW 1971c).

2.9.3 Surface Drainage

The surface drainage near the Old Outfall (IHSS 143) has been modified since this IHSS was active. The Old Outfall, during the time in which it was active, received surface runoff from the south via a culvert, and liquid discharge from the effluent of Building 771 to the southeast. The water entered into a small stream channel and flowed northward into North Walnut Creek (Figure 2-13).

The Old Outfall Area is presently a flat area, as it has been covered with fill. The surface drainage system near this unit now consists of a small ditch, which diverts runoff across a portion of this IHSS and subsequently into North Walnut Creek via a culvert beneath the PSZ. In addition, an intermittent stream flows from the southwest across the Old Outfall Area to the northeast through a culvert buried beneath this IHSS. Water flowing within this channel originates in the buffer zone west of the PSZ.

2.9.4 Nature of Contamination and Previous Investigations

Soil investigations took place on several occasions near the Old Outfall. The first report of soil contamination in the area was in May 1956, and a maximum concentration of 130 d/m/g gross alpha was recorded. Soil samples were analyzed at the Outfall Area again in May 1958 and concentrations were reported as high as 2,000 d/m/g gross alpha (DOW 1971a).

In April 1970, hot spots detected at the Old Outfall reported concentrations greater than 190,000 d/m/g. In June 1971, soil samples collected between Building 771, the Old Outfall, and North Walnut Creek showed plutonium activities ranging between 60,000 d/m/g and 200,000 d/m/g (DOW 1971b).

Discharges from the Old Outfall and leaching of these discharges through the Old Outfall Area may have contributed to contamination in North Walnut Creek. This is supported by plutonium analyses of the creek's water. The average plutonium concentration in North Walnut Creek's water in December 1970 was 0.4 pCi/l. The 3-month plutonium moving average in Walnut Creek was 1.1 pCi/l in December (DOW 1971b). Sediment samples collected from North Walnut Creek during the beginning of 1970 were also found to contain plutonium, ranging in concentration from 4 to 36 d/m/g (DOW 1973).

A soil investigation also took place in 1970 following a May 1968 incident when a broken sewer line caused the sewage lift station to overflow onto the Old Outfall Area. Radioactivity levels at the Old Outfall were recorded to be as high as 100,000 dpm/g in this investigation. Based on these results, removal of the contaminated soil began in February 1971 (Figure 2-13) (Rockwell 1988). During initial soil removal activities, the soil showed levels ranging between 120 and 1,300 d/m. Rocks, after being completely dried, recorded levels as high as 10,000 c/m by direct instrument measurements (DOW 1971a). The area east of the initial excavation (an area of approximately 25 x 30 feet), after removal of approximately 1 foot of soil, still had soil contamination present at depth (Figure 2-13). The underlying soil was measured to have levels between 2,000 and 3,000 d/m (DOW 1971a). The depth of penetration of plutonium into the soil was believed to be due to the soap and detergents discharged from the laundry holding tanks of Building 771 (DOW 1971a). Soil removal activities were completed in early August 1971. The highest soil contamination level recorded during soil removal activities was 29,000 d/m/gm (DOW 1971c). Final surveys of the area following remediation showed no direct alpha count greater than 250 c/m and results averaged 34 d/m/gm with a maximum of 150 d/m/gm (DOW 1971c).

2.9.5 Geology and Hydrology

The geology beneath and near the Old Outfall has been characterized by its geographic location and from lithologic data obtained from monitoring well P219189, located 450 feet to the east (Figure 2-12).

The two surficial geologic units likely to be beneath the Old Outfall are valley fill alluvium and colluvium. An intermittent stream once flowed across this IHSS, contributing minor deposits of valley fill alluvium. On the slopes of this drainage system and to the south of this IHSS, colluvium has been deposited across this area by slope wash and downslope creep of the Rocky Flats Alluvium and/or Arapahoe Formation.

The rock units encountered in well P219189 located 450 feet to the east were fill (approximately 10 feet) overlying the Arapahoe Formation. The fill in this area is described as a dark yellowish-brown, poorly sorted, unconsolidated gravelly sand unit, with angular to subrounded fine- to coarse grains. Fill is known to have been placed in the area of the Old Outfall; however, the thickness of fill is unknown. The Arapahoe Formation is described as a claystone to silty claystone in this area.

2.10 SOIL DUMP AREA (IHSS 156.2)

2.10.1 Location and Description

The Soil Dump Area (IHSS 156.2) is located within the buffer zone, approximately 10 feet northeast of the northeastern boundary of the security area of the Plant facility, and northeast of the Triangle Area (Figure 2-11). Geographically, this IHSS is on an east-west trending interfluve that separates North and South Walnut creeks in the vicinity of the A-series and B-series Detention Ponds. A dirt road crosses through this unit in a northeast, southwest direction. The Soil Dump Area covers an area of approximately 255,000 square feet (5.9 acres).

2.10.2 History

The Soil Dump Area was an area that received between 50 to 75 dump truck loads of soil containing low levels of plutonium. These soils were excavated during the construction of Parking Area No. 334 located in the middle of the western half of the Plant production area. However, the excavated soils removed from the Parking Area originally had been excavated around and near Building 774. Building 774 is located approximately 100 feet east of Building 771 near the Old Outfall Area (Figure 2-12). Asphalt debris and concrete remains were also found within the Soil Dump Area.

2.10.3 Surface Drainage

Surface runoff across this IHSS is minimal as this unit is situated on a flat area that is sparsely vegetated (Figure 2-11). However, runoff near the northern boundary flows toward North Walnut Creek and the A-series Ponds and runoff near the southern boundary flows toward South Walnut Creek and the B-series Ponds. Surface runoff that may flow toward the northeast boundary may cross the East Area Spray Field (IHSS 216.1) before draining into North and/or South Walnut Creeks.

2.10.4 Nature of Contamination and Previous Investigations

Soils placed onto the Soil Dump Area contained low levels of plutonium (Rockwell 1988). The volume of plutonium within these soils and concentrations are not known (Rockwell 1988). A piezometer (TH-14) was installed in the northwest corner of this IHSS (exact location unknown), however, no records or completion details of this well are available (Rockwell 1988).

2.10.5 Geology and Hydrology

The geology beneath this IHSS has not fully been characterized as no monitoring wells have been drilled through this unit. Based on the geographic location of this IHSS, the surficial geologic map of the OU6 area (Figure 1-5), and the surficial lithologic unit encountered in a nearby monitoring well (B213789) the Rocky Flats Alluvium is the formation beneath this IHSS. The Rocky Flats Alluvium is about 6 feet thick in this area based on well B213789. The Rocky Flats Alluvium is described as a poorly sorted, unconsolidated sandy clay, yellowish-brown to brown, and calcareous. The Arapahoe Formation underlies the Rocky Flats Alluvium and in this area the Arapahoe Formation is described as a poorly sorted, unconsolidated, calcareous weathered clayey sandstone to claystone with oxide staining. Outcrops of the Arapahoe Formation are found at three small locations in a road cut near the western boundary of this IHSS. The lithology found at two of these bedrock outcrops are sandstones while the other is a claystone unit (Figure 1-5).

Hydrologic studies beneath and near this IHSS have described the Rocky Flats Alluvium in this area to be unsaturated (Rockwell 1988). An alluvium monitoring well (B213789) located approximately 100 feet south of the southern most boundary of this IHSS is dry during most of the year (Figure 2-11). Only about ½ foot of water was reported in this well in August 1990.

2.11 CONCEPTUAL MODELS

Phase I conceptual models for each IHSS or similar IHSSs were developed and are presented in the following subsections. The Phase I models are based on a review of the historical data and previous investigations conducted near the IHSSs. In the following sections, the conceptual models will describe contaminant sources, the potential migration and exposure pathways, and potential receptors for each IHSS.

2.11.1 The A-series Ponds (IHSSs 142.1, 142.2, 142.3 and 142.4) and IHSS 142.12

The A-series Ponds (Ponds A-1, A-2, A-3, and A-4) are located in North Walnut Creek, northeast of the main security area of the Rocky Flats Plant. These detention ponds are used to capture and control surface runoff from the northern part of the Rocky Flats production facilities. Various discharges that contained nitrates and radioactive substances, including plutonium and uranium, along with laundry wastes containing plutonium, flowed into North Walnut Creek upstream of the A-series detention ponds. This contributed significant amounts of plutonium to the stream sediments of North Walnut Creek and in the sediments of the A-series Ponds. Numerous investigations have taken place at the A-series ponds. The results are discussed in subsection 2.2.4. Potential sources of contamination in the A-series ponds are water and sediments in the ponds.

Air Pathway - The air pathway from these ponds is not considered to be a potential pathway since contaminated particulate are generally not available for wind-blown transportation. Volatile organic compounds, if present, could pose a concern through atmospheric emissions.

Surface Water Pathway - The surface pathway is considered to be the most likely migration pathway from the A-series ponds. The discharge from the A-series Ponds is currently being treated at Pond A-4 prior to being discharged into Walnut Creek toward Great Western Reservoir, where it is diverted around the reservoir by the Broomfield Diversion Ditch and into Big Dry Creek. The discharges from Pond A-4 are monitored for contaminants to comply with an NPDES permit. Aquatic biota, birds and mammals are potential on-site receptors of surface water. Potential off-site receptors of surface water from the A-series Ponds are the off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek east of Indiana Street. The surface water pathway is considered the most direct of the exposure pathways from these ponds.

Groundwater Pathway - The groundwater pathway is also a potential concern. The ponds are not lined and migration and infiltration of contaminants through the sediments and alluvium to the groundwater is probably occurring. Groundwater flow in this area is likely to the east. Animal and human receptors could contact groundwater surfacing in Walnut Creek. Other potential human receptors for the groundwater are off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water pathway because of the slower movement of groundwater, the distance to potential receptors, and because of the ability of the aquifer to retard and absorb contaminants.

2.11.2 B-Series Ponds (IHSSs 142.5, 142.6, 142.7, 142.8 and 142.9)

The B-series ponds (B-1, B-2, B-3, B-4, and B-5) are located in South Walnut Creek, east of the eastern perimeter of the main security area of the Rocky Flats Plant. These ponds are used to capture and control surface water runoff from the eastern and central portions of the Rocky Flats production facilities. Decontamination process water, laundry wastewater, and sewage treatment plant effluent containing nitrates, plutonium, and uranium have been discharged to the B-series ponds over various periods. Investigations have been conducted in South Walnut Creek and the B-series ponds. The results are discussed in subsection 2.3.4. Potential sources of contamination in the B-series ponds are water and sediments in the ponds.

Air Pathway - The air pathway from the B-series ponds is not considered to be a potential pathway since contaminated particulates are generally not available for wind-blown transportation. Volatile organic compounds, if present, could pose a concern through atmospheric emissions.

Surface Water Pathway - The surface water pathway is considered to be the most likely migration pathway from the B-series ponds. The discharge from the B-series Ponds is currently being treated at Pond A-4 prior to being discharged into Walnut Creek toward Great Western Reservoir, where it is diverted around the reservoir by the Broomfield Diversion Ditch and into Big Dry Creek. The discharges from Pond A-4 are monitored for contaminants to comply with an NPDES permit. Aquatic biota, birds, and mammals are potential on-site receptors of surface water. Potential off-site receptors of surface water from the B-series Ponds are the off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek east of Indiana Street. The surface water pathway is considered the most direct of the exposure pathways from these ponds.

Groundwater Pathway - The groundwater pathway is also a potential pathway of concern. The ponds are not lined and migration and infiltration of contaminants through the sediments and alluvium to the groundwater is probably occurring. Groundwater flow in this area is likely to the east. Animal and human receptors could contact groundwater surfacing in Walnut Creek. Other potential human receptors for the groundwater are off-site groundwater users east of Indiana Street. This pathway is not as direct as the surface water pathway because of the slower movement of groundwater, the distance to potential receptors and because of the ability of the aquifer to retard and absorb contaminants.

2.11.3 North, South, and Pond Area Spray Fields (IHSSs 167.1, 167.2 and 167.3)

These former spray fields are located north of the security area of the plant within the buffer zone. These fields were used to spray and evaporate the water that collected in the East and West Landfill Ponds. Excessive runoff caused spraying to be stopped at the North and South Spray Fields. Limited chemical data are available and are described in subsection 2.4.4. Contaminated spray water may have contaminated the surface soils on the spray field areas, and these soils would be a source.

Air Pathway

The air pathway from these spray fields is considered to be a potential pathway. Contaminated spray water may have contaminated the surface soils, which can become airborne during periods of high winds. Emissions of volatile organic compounds are unlikely, since spraying should have already volatilized the organics present. Receptors of airborne contamination are downwind animals and humans.

Surface Water Pathway

Surface water is potentially a pathway during periods when runoff crosses the potentially contaminated surface soils. However, runoff from the spray fields is contained in the A-series Ponds and the landfill pond. Aquatic biota, birds and mammals are potential on-site receptors. Potential off-site receptors of surface water from the Spray Fields are the off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek.

Groundwater Pathway

Groundwater is a less likely pathway for potential contamination at the spray fields. Based on the past use of the spray fields, precipitation falling on the fields tends to run off to the drainages, so there is little infiltration. Animal and human receptors could contact groundwater surfacing in Walnut Creek. Other potential receptors are groundwater users east of Indiana Street.

2.11.4 East Area Spray Field (IHSS 216.1)

This spray field (IHSS 166.1) is located on an interfluve separating South and North Walnut creeks within the buffer zone. For a few months in 1989, this area was used to accommodate the spray evaporation from the water in Pond B-3. Surface water analyses conducted during 1989 for the water in Pond B-3 are presented in subsection 2.5.4. Contaminated spray water may have contaminated the surface soils on the East Area Spray Field and these soils could be a source.

Air Pathway

The air pathway from the East Spray Field is considered to be a potential pathway. Contaminated spray water may have contaminated the surface soils, which can become airborne during periods of high winds. Emissions of volatile organic compounds are unlikely, since spraying should have already volatilized the organics present. Receptors of airborne contamination are downwind animals and humans.

Surface Water Pathway

Surface water is potentially a pathway during periods when runoff crosses the potentially contaminated surface soils. However, runoff from the spray fields is contained in the A-series and B-series Ponds. Aquatic biota, birds and mammals are potential on-site receptors. Potential off-site receptors of surface water from this spray field are off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek.

Groundwater Pathway

Groundwater is a less likely pathway for potential contamination at the East Spray Field. Based on the past use of the spray field, precipitation falling on the field tends to run off toward North and South Walnut creeks, so there is little infiltration. Animal and human receptor could contact groundwater surfacing in Walnut Creek. Other potential receptors are groundwater users east of Indiana Street.

2.11.5 Trenches A, B, and C (IHSSs 166.1, 166.2 and 166.3)

These trenches are located on a plateau separating North Walnut Creek from the unnamed tributary to the north. Trenches A and B received sewage sludge which contained uranium and/or plutonium. Trench C is also suspected to have received sewage sludge. Soil covers were placed over the trenches (date unknown). The source of contamination at the trenches, if present, is the material in the trenches.

Surface Water and Air Pathways - Surface water runoff probably does not come in contact with wastes in these units because of the soil cover present. Similarly, release of contaminants into the air should be inhibited by the soil cover over these units. Thus, these potential pathways will not be considered for these units.

Groundwater Pathway - The most likely migration pathway for potential contaminants from Trenches A, B and C is through groundwater flow. The groundwater table is shallow beneath this IHSS (5 feet below ground surface) and groundwater may be in contact with the materials in the trenches. The groundwater is likely to flow eastward toward Walnut Creek, where the alluvial aquifer is probably present. The surface depression over IHSS 166.2 causes occasional ponding, which could lead to increased infiltration of water into this unit. On-site animal or human receptors could contact groundwater surfacing in Walnut Creek. Other potential human receptors of the groundwater are off-site groundwater users east of Indiana Street.

2.11.6 Sludge Dispersal Area (IHSS 141)

The Sludge Dispersal Area is located along the eastern perimeter of the main security zone of the Rocky Flats Plant. Prior to 1983, the Sludge Dispersal Area was an area that may have received airborne radioactive particles from dried sludge packaging operations. Elevated levels of plutonium occurred in the sludge. Surface soils in the area may have been contaminated by the airborne particles.

Air Pathway

The air pathway is the primary pathway of concern since it was the original method of migration. The dispersed sludge can become airborne during periods of high winds. Receptors are downwind animals and humans. Off-site animals and humans could also be potential receptors.

Surface Water

Surface water is potentially a pathway during periods when runoff crosses the potentially contaminated surface soils. Runoff from the Sludge Dispersal Area flows into the B-series Ponds. Aquatic biota, birds and mammals are potential on-site receptors. Potential off-site receptors of surface water from the Sludge Dispersal Area are off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek.

Groundwater Pathway

Groundwater is not considered a pathway for potential contamination. The unit is located on a slope, so water is likely to run off.

2.11.7 Triangle Area (IHSS 165)

The Triangle Area is located primarily in the northeastern corner of the PSZ. The area was used as a storage site for miscellaneous wastes, including 55-gallon drums containing plutonium-contaminated wastes, between 1966 and 1975. Cleanup activities have been conducted in the Triangle Area on several occasions, and fill has been placed in the area.

Surface Waters and Air Pathway

Surface water runoff probably does not come in contact with wastes in the Triangle Area since the wastes have been removed and fill has been placed over the area. This cover also reduces the potential for migration via the air and surface water pathway. Thus, these pathways are not considered for this unit.

Groundwater Pathway

Wastes previously spilled at the site may have migrated to the relatively shallow groundwater table. The wastes have been removed, so continued migration from existing sources is unlikely. Groundwater may move from the Triangle Area toward both North and South Walnut creeks where it could enter the surface water. The nearest potential receptors of groundwater are primarily off-site, downgradient human groundwater users east of Indiana Street.

2.11.8 Old Outfall (IHSS 143)

The area of the Old Outfall is located within the PSZ near Buildings 773 and 771. The area received process and/or laundry wastes between the 1950s and the 1970s. The area was remediated in 1971 and has since been covered with fill. The presence or absence of hazardous substances will be investigated during the Phase I Investigation. If contamination exists, the potential exposure pathways and receptors are similar to the Triangle Area described above.

2.11.9 Soil Dump Area (IHSS 156.2)

The Soil Dump Area is located within the buffer zone, northeast of the northeastern boundary of the security area of the Plant. This IHSS received contaminated soils containing low levels of plutonium, asphalt debris and concrete remains. The source of contamination at this IHSS would be from the soils dumped at this site.

<u>Air Pathway</u>

The air pathway is a potential pathway of concern from the Soil Dump Area as the plutonium contaminated soils can become airborne during periods of high winds. Receptors of airborne contamination are downwind animals and humans.

<u>Surface Water Pathway</u>

Surface water is a potential pathway when runoff crosses the Soil Dump Area and the potentially contaminated surface soils on this unit. However, runoff from this IHSS is contained within the A-series Ponds to the north and the B-series Ponds to the south. Aquatic biota, birds and mammals are potential on-site receptors. Potential off-site receptors of surface water from the Soil Dump Area are the off-site surface water users of the Broomfield Diversion Ditch and Big Dry Creek.

<u>Groundwater Pathway</u>

Groundwater is not believed to be present beneath the Soil Dump Area as the Rocky Flats Alluvium in the immediate area is known to be unsaturated. Infiltration, if any, that may occur through this unit drains toward North and South Walnut creeks where the water may eventually enter the surface water. Thus, groundwater as a potential pathway is not considered for this unit.

3.0
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section provides a preliminary identification of potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for surface water and groundwater at Operable Unit 6 (OU6). The summary of possible ARARs presented is based on current federal and state health and environmental statues and regulations and the chemicals suspected to be present at OU6. The preliminary identification and examination of potential ARARs will provide for the use of appropriate analytical detection limits during the RFI/RI. As data become available during the Phase I RI, specific ARARs will be proposed for OU6. The Corrective Measures Study (CMS) Feasibility Study (FS) report will further address chemical-specific ARARs as well as action- and location-specific ARARs in the development and evaluation of remedial alternatives.

3.1 THE ARAR BASIS

The basis for ARARs is cited in Section 121(d) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), which requires that Fund-financed, enforcement, and federal facility remedial actions comply with applicable or relevant and appropriate federal laws or promulgated state laws, whichever is more stringent. For the purposes of identification and notification of promulgated state standards, the term "promulgated" means that the standards are of general applicability and are legally enforceable (NCP, 40 CFR 300.400(g)(4)). Colorado Department of Health (CDH) Water Quality Control Commission (WQCC) groundwater standards are to-be-considered (TBC) since they are not yet enforceable.

3.2 THE ARAR PROCESS

A screening and analysis process will be used to determine the potential ARARs to be applied to OU6. The analysis will address compliance with chemical-, location-, and action-specific ARARs in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The screening process will consider relevant and appropriate requirements in the same manner as applicable requirements. When more than one ARAR is identified, the most stringent ARAR will be used.

The first step in identifying potential ARARs will occur after the initial scoping and site characterization and will involve the analysis of the chemicals present at the site and any location-specific characteristics at the site. Once the chemicals have been identified, the presence or absence of chemical-specific ARARs will be determined. Chemical-specific ARARs will be derived primarily from federal and state health and environmental statues and regulations, including the following:

- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) applied to both surface and groundwater

- Clean Water Act (CWA) Water Quality Criteria (WQC) applied to surface water

- RCRA Subpart F Groundwater Concentration Limits (40 CFR 264.94) - applied to groundwater

- Colorado Department of Health (CDH) surface water standards for Woman Creek and Walnut Creek (5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990) - applied to surface water

- CDH WQCC proposed statewide and classified groundwater area standards (5 CCR 1002-8, Section 3.11) - applied to groundwater as TBC

A summary of chemical-specific standards or potential ARARs based on the above regulations and contaminants that may be found at OU6 is presented in Table 3-1, Groundwater Quality Standards, and Table 3-2, Federal Surface Water Quality Standards and Table 3-3 State Surface Water Quality Standards. These potential chemical-specific ARARs and accompanying regulations will be screened to determine their jurisdictional requirements and applicability to OU6. If the requirements are not applicable, they will be further screened to determine whether they are relevant and appropriate to the particular site-specific conditions at OU6. Where ARARs do not exist for a particular chemical or where existing ARARs are not protective of human health or the environment, to-be-considered (TBC) criteria, guidances, proposed standards, and advisories will be evaluated for use. Standards identified as potential ARARs, as well as TBC criteria, will be analyzed according to the procedures outlined in the Superfund Public Health Evaluation Manual (EPA 1986), NCP, and CERCLA Compliance with Other Laws Manual (EPA 1989).

3.2.1 ARARs

"Applicable requirements," as defined in 40 CFR 300.5, are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable." "Relevant and appropriate requirements," also defined in 40 CFR 300.5, are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Dissolved Oxygen	Field Parameter										
pH	Field Parameter	6.5-8.5 *							6.5-8.5	6.5-8.5	
Specific Conductance	Field Parameter										
Temperature	Field Parameter										
Total Dissolved Solids	Indicator	500 mg/l *									400 mg/l (1)
Bicarbonate	Anion										
Carbonate	Anion										
Chloride	Anion	250 mg/l *							250 mg/l		
Fluoride	Anion	4 mg/l, 2 mg/l*		4 mg/l				4 mg/l		2 mg/l	
N as Nitrate	Anion	10 mg/l						10.0 mg/l			
N as Nitrate+Nitrite	Anion		10 mg/l		10 mg/l					100 mg/l	
N as Nitrite	Anion		1 mg/l		1 mg/l			1.0 mg/l		10 mg/l	
Potassium	Anion										
Sulfate	Anion	250 mg/l *							250 mg/l		
Aluminum	Metal		0.05 to 0.2 mg/l*							5.0 mg/l	
Antimony	Metal										
Arsenic	Metal	50 ug/l				50 ug/l		50 ug/l		100 ug/l	
Arsenic III	Metal										
Arsenic V	Metal										
Barium	Metal	1.0 mg/l				1 mg/l		1.0 mg/l			
Beryllium	Metal									100 ug/l	
Cadmium	Metal	10 ug/l	5 ug/l		5 ug/l	10 ug/l		10 ug/l		10 ug/l	
Calcium	Metal										
Chromium	Metal	50 ug/l	100 ug/l		100 ug/l	50 ug/l		50 ug/l		100 ug/l	
Chromium III	Metal										
Chromium VI	Metal										
Cobalt	Metal									50 ug/l	
Copper	Metal	1 mg/l *							1 mg/l	200 ug/l	

3-1.1

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Cyanide	Metal							200 ug/l			
Iron	Metal	300 ug/l *							300 ug/l	5 mg/l	
Lead	Metal	50 ug/l				50 ug/l		50 ug/l		100 ug/l	
Magnesium	Metal										
Manganese	Metal	50 ug/l *							50 ug/l	200 ug/l	
Mercury	Metal	2 ug/l			2 ug/l	2 ug/l		2 ug/l		10 ug/l	
Molybdenum	Metal										
Nickel	Metal									200 ug/l	
Selenium	Metal	10 ug/l	50 ug/l		50 ug/l	10 ug/l		10 ug/l		20 ug/l	
Silver	Metal	50 ug/l	100 ug/l			50 ug/l		50 ug/l			
Sodium	Metal										
Thallium	Metal										
Tin	Metal										
Titanium	Metal										
Tungsten	Metal										
Vanadium	Metal									100 ug/l	
Zinc	Metal	5 mg/l *							5 mg/l	2.0 mg/l	
Americium 241	Radionuclide										
Cesium 137	Radionuclide										
Cesium 134	Radionuclide						80 pCi/l (2)	80 pCi/l			
Gross Alpha	Radionuclide	15 pCi/l						15 pCi/l			
Gross Beta	Radionuclide	4 mrem/yr						4 mrem/yr			
Plutonium 238+239+240	Radionuclide						15 pCi/l (2)	15 pCi/l			
Radium 226+228	Radionuclide	5 pCi/l					5 pCi/l (2)	5 pCi/l			
Strontium 90	Radionuclide						8 pCi/l (2)	8 pCi/l			
Thorium 230+232	Radionuclide						60 pCi/l (2)	60 pCi/l			
Tritium	Radionuclide						20,000 pCi/l(2)	20,000 pCi/l			
Uranium 233+234	Radionuclide										

3-1.2

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
ameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
anium 235	Radionuclide										
anium 238	Radionuclide										
anium (total)	Radionuclide										
-Dichloroethane	Volatile										
-Dichloroethene	Volatile	7 ug/l		7 ug/l			7 ug/l				
,1-Trichloroethane	Volatile	200 ug/l		200 ug/l			200 ug/l				
,2,2-Tetrachloroethane	Volatile										
,2-Trichloroethane	Volatile						28 ug/l (6)				
:-Dichloroethane	Volatile	5 ug/l		0 ug/l			5 ug/l				
!-Dichloroethene	Volatile						70 ug/l				
!-Dichloropropane	Volatile		5 ug/l		0 ug/l		560 ng/l				
3utanone	Volatile										
Iexanone	Volatile										
Methyl-2-pentanone	Volatile										
:etone	Volatile										
:nzene	Volatile	5 ug/l		0 mg/l							
:nzo(a)anthracene	Volatile										
:nzo(a)pyrene	Volatile										
:nzo(b)fluoranthene	Volatile										
:nzo(g,h,i)perylene	Volatile										
:nzo(k)fluoranthene	Volatile										
omodichloromethane	Volatile										
romoform	Volatile										
romomethane	Volatile										
hlorinated Benzenes	Volatile										
hlorobenzene	Volatile						300 ug/l				
hloroethane	Volatile										
hloroform	Volatile	Tot THM**					Tot THM**				

3-1.3

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

Parameter	Type	FEDERAL STANDARDS: SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	STATE STANDARDS (TBCs): CDH WQCC Groundwater Quality Standards (d): Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Chloromethane	Volatile	<100 ug/l					<100 ug/l				
cis-1,3-Dichloropropene	Volatile										
Dibromochloromethane	Volatile										
Ethyl Benzene	Volatile		0.7 mg/l		0.7 mg/l		680 ug/l				
Fluoranthene	Volatile										
Haloethers	Volatile										
Halomethanes	Volatile										
Indeno(1,2,3-cd)pyrene	Volatile										
Methylene Chloride	Volatile										
Phenanthrene	Volatile							1 ug/l			
Phenol	Volatile										
Polynuclear Aromatic Hydrocarbons	Volatile										
Pyrene	Volatile										
Styrene	Volatile		0.1 mg/l		0.1 mg/l						
Tetrachloroethanes	Volatile										
Tetrachloroethene	Volatile		5 ug/l		0 ug/l		10 ug/l				
Total Xylenes	Volatile		10 mg/l		10 mg/l						
trans-1,3-Dichloropropene	Volatile										
Trichloroethanes	Volatile										
Trichloroethene	Volatile	5 ug/l		0 ug/l			5 ug/l				
Vinyl Acetate	Volatile										
1,2-Dichlorobenzene	Semi-Volatile						620 ug/l				
1,3-Dichlorobenzene (ortho)	Semi-Volatile						620 ug/l				
1,4-Dichlorobenzene (para)	Semi-Volatile	75 ug/l		75 ug/l			75 ug/l				
1,2,4-Trichlorobenzene	Semi-Volatile										
2-Chloronaphthalene	Semi-Volatile										

3-1.4

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
2-Chlorophenol	Semi-Volatile										
2-Methylnaphthalene	Semi-Volatile										
2-Methylphenol	Semi-Volatile										
2-Nitroaniline	Semi-Volatile										
2-Nitrophenol	Semi-Volatile										
2,4-Dichlorophenol	Semi-Volatile						21 ug/l				
2,4-Dimethylphenol	Semi-Volatile										
2,4-Dinitrophenol	Semi-Volatile										
2,4-Dinitrotoluene	Semi-Volatile										
2,4,5-Trichlorophenol	Semi-Volatile						700 ug/l				
2,4,6-Trichlorophenol	Semi-Volatile										
3-Nitroaniline	Semi-Volatile										
3,3-Dichlorobenzidine	Semi-Volatile										
4-Bromophenyl Phenylether	Semi-Volatile										
4-Chloroaniline	Semi-Volatile										
4-Chlorophenyl Phenyl Ether	Semi-Volatile										
4-Chloro-3-methylphenol	Semi-Volatile										
4-Methylphenol	Semi-Volatile										
4-Nitroaniline	Semi-Volatile										
4-Nitrophenol	Semi-Volatile										
4,6-Dinitro-2-methylphenol	Semi-Volatile										
Acenaphthene	Semi-Volatile										
Acetone	Semi-Volatile										
Acrylonitrile	Semi-Volatile										
Aldrin	Semi-Volatile						2 ng/l				
Anthracene	Semi-Volatile										
Atrazine	Semi-Volatile		3 ug/l		3 ug/l		0.2 ng/l				
Benzidine	Semi-Volatile							0.1 ug/l			
Benzoic Acid	Semi-Volatile										

3-1.5

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Benzyl Alcohol	Semi-Volatile										
bis(2-Chloroethoxy)methane	Semi-Volatile										
bis(2-Chloroethyl)ether	Semi-Volatile						30 ng/l				
bis(2-Chloroisopropyl)ether	Semi-Volatile										
bis(2-Ethylhexyl)phthalate	Semi-Volatile										
Butyl Benzylphthalate	Semi-Volatile										
Carbon Disulfide	Semi-Volatile										
Carbon Tetrachloride	Semi-Volatile	5 ug/l		0 mg/l			5 ug/l				
Chlorinated Benzenes	Semi-Volatile										
Chlorinated Ethers	Semi-Volatile										
Chlorinated Napthalenes	Semi-Volatile										
Chloroalkylethers	Semi-Volatile										
Chlorodane	Semi-Volatile		2 ug/l				0.03 ug/l	4 ng/l			
Chlorophenol	Semi-Volatile							1 ug/l			
DDT	Semi-Volatile						0.1 ug/l				
DDE	Semi-Volatile										
DDD	Semi-Volatile										
Dibenzofuran	Semi-Volatile										
Dibenz(a,h)anthracene	Semi-Volatile										
Dichlorobenzenes	Semi-Volatile										
Dichlorobenzidine	Semi-Volatile						2 ng/l				
Dichloroethenes	Semi-Volatile										
Dichloromethane	Semi-Volatile										
Dieldrin	Semi-Volatile										
Diethylphthalate	Semi-Volatile										
Dimethylphthalate	Semi-Volatile										
Di-n-butylphthalate	Semi-Volatile										
Dinitrotoluene	Semi-Volatile										
Di-n-octylphthalate	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
Dioxin	Semi-Volatile						0.22 pg/l				
Endosulfan I	Semi-Volatile										
Endosulfan II	Semi-Volatile										
Endosulfan Sulfate	Semi-Volatile										
Endrin	Semi-Volatile	0.2 ug/l					0.2 ug/l	0.2 ug/l			
Endrin Ketone	Semi-Volatile										
Fluorene	Semi-Volatile										
Halomethanes	Semi-Volatile	0.10 mg/l					100 ug/l				
Heptachlor	Semi-Volatile		0.4 ug/l				8 ng/l				
Heptachlor Epoxide	Semi-Volatile		0.2 ug/l				4 ng/l				
Hexachlorobenzene	Semi-Volatile						0.02 ug/l				
Hexachlorobutadiene	Semi-Volatile						14 ug/l (6)				
Hexachlorocyclopentadiene	Semi-Volatile						49 ug/l (6)				
Hexachlorocyclohexane, Alpha	Semi-Volatile										
Hexachlorocyclohexane, Beta	Semi-Volatile										
Hexachlorocyclohexane, (Lindane) Gama	Semi-Volatile	4 ug/l	0.2 ug/l		0.2 ug/l		4 ug/l	4 ug/l			
Hexachlorocyclohexane, Technical	Semi-Volatile										
Hexachloroethane	Semi-Volatile										
Isophorone	Semi-Volatile						1.05 mg/l (6)				
Methoxychlor	Semi-Volatile	0.1 mg/l	0.04 mg/l		0.04 mg/l		100 ug/l	100 ug/l			
Naphthalene	Semi-Volatile										
Nitrobenzene	Semi-Volatile						3.5 ug/l (6)				
Nitrophenols	Semi-Volatile										
Nitrosamines	Semi-Volatile										
Nitrosodibutylamine	Semi-Volatile										
Nitrosodiethylamine	Semi-Volatile										
Nitrosodimethylamine	Semi-Volatile										
Nitrosopyrrolidine	Semi-Volatile										
N-Nitrosodiphenylamine	Semi-Volatile										

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs FOR OU6, WALNUT CREEK PRIORITY DRAINAGE GROUNDWATER QUALITY STANDARDS

		FEDERAL STANDARDS					STATE STANDARDS (TBCs)				
							CDH WQCC Groundwater Quality Standards (d)				
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40 CFR 264.94) (c)	Tables A & B Statewide	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agricultural	Table 4 TDS Standard
N-Nitroso-di-n-dipropylamine	Semi-Volatile										
PCBs	Semi-Volatile		0.5 ug/l				5 ng/l				
Pentachlorinated Ethanes	Semi-Volatile										
Pentachlorophenol	Semi-Volatile										
Phthalate Esters	Semi-Volatile										
Simazine	Semi-Volatile										
Toluene	Semi-Volatile		1 mg/l		1 mg/l		2.42 mg/l				
Toxaphene	Semi-Volatile		3 ug/l				5 ug/l	5 ug/l			
Vinyl Chloride	Semi-Volatile	2 ug/l		0 ug/l			2 ug/l				

EXPLANATION OF TABLE

* = secondary maximum contaminant level
** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH = Colorado Department of Health
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
WQCC = Water Quality Control Commission

(1) TDS standard - see Table 4 in (d)
(2) radionuclide standards - see sec. 3.11.5(c)2 in (d)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526)
(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988
(d) CDH/Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 9/11/1990

3-1.8

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Dissolved Oxygen	Field Parameter					5.0 mg/l			
pH	Field Parameter	6.5-8.5 *					6.5-9		
Specific Conductance	Field Parameter								
Temperature	Field Parameter					SS	SS		
Total Dissolved Solids	Indicator	500 mg/l *				SS	SS	250 mg/l	
Bicarbonate	Anion								
Carbonate	Anion								
Chloride	Anion	250 mg/l *							
Flouride	Anion	4 mg/l, 2 mg/l*		4 mg/l					
N as Nitrate	Anion	10 mg/l			10 mg/l			10 mg/l	
N as Nitrate+Nitrite	Anion		10 mg/l		10 mg/l				
N as Nitrite	Anion		1 mg/l		1 mg/l				
Potassium	Anion								
Sulfate	Anion	250 mg/l *							
Aluminum	Metal		0.05 to 0.2 mg/l*						
Antimony	Metal					9 mg/l	1.6 mg/l	146 ug/l	45 mg/l
Arsenic	Metal	50 ug/l						2.2 ng/l	17.5 ng/l
Arsenic III	Metal					360 ug/l	190 ug/l		
Arsenic V	Metal					850 ug/l	48 ug/l		
Barium	Metal	1 mg/l						1 mg/l	
Beryllium	Metal					130 ug/l	5.3 ug/l	6.8 ng/l**	117 ng/l**
Cadmium	Metal	10 ug/l	5 ug/l		5 ug/l	3.9 ug/l (3)	1.1 ug/l (3)	10 ug/l	
Calcium	Metal								
Chromium	Metal	50 ug/l	100 ug/l		100 ug/l				
Chromium III	Metal					1.7 mg/l	210 ug/l	170 mg/l	3433 mg/l
Chromium VI	Metal					16 ug/l	11 ug/l	50 ug/l	
Cobalt	Metal								
Copper	Metal	1 mg/l *				18 ug/l (3)	12 ug/l (3)		
Cyanide	Metal					22 ug/l	5.2 ug/l	200 ug/l	

3-2.1

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE
FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Iron	Metal	300 ug/l *					1.0 mg/l	300 ug/l	
Lead	Metal	50 ug/l				82 ug/l (3)	3.2 ug/l (3)	50 ug/l	
Magnesium	Metal								
Manganese	Metal	50 ug/l *						50 ug/l	100 ug/l
Mercury	Metal	2 ug/l			2 ug/l	2.4 ug/l	12 ng/l	144 ng/l	146 ng/l
Molybdenum	Metal								
Nickel	Metal					1.4 mg/l (3)	160 ug/l (3)	13.4 ug/l	100 ug/l
Selenium	Metal	10 ug/l	50 ug/l		50 ug/l	260 ug/l	36 ug/l	10 ug/l	
Silver	Metal	50 ug/l	100 ug/l			4.1 ug/l (3)	120 ng/l	50 ug/l	
Sodium	Metal								
Thallium	Metal					1.4 mg/l (1)	40 ug/l (1)	13 ug/l	48 ug/l
Tin	Metal								
Titanium	Metal								
Tungsten	Metal								
Vanadium	Metal								
Zinc	Metal	5 mg/l *				120 ug/l (3)	110 ug/l (3)		
Americium 241	Radionuclide								
Cesium 137	Radionuclide								
Cesium 134	Radionuclide								
Gross Alpha	Radionuclide	15 pCi/l							
Gross Beta	Radionuclide	4 mrem/yr							
Plutonium 238+239+240	Radionuclide								
Radium 226+228	Radionuclide	5 pCi/l							
Strontium 90	Radionuclide								
Thorium 230+232	Radionuclide								
Tritium	Radionuclide								
Uranium 233+234	Radionuclide								
Uranium 235	Radionuclide								
Uranium 238	Radionuclide								

3-2.2

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Uranium (total)	Radionuclide								
1,1-Dichloroethane	Volatile								
1,1-Dichloroethene	Volatile	7 ug/l		7 ug/l					
1,1,1-Trichloroethane	Volatile	200 ug/l		200 ug/l				18.4 mg/l	1.03 g/l
1,1,2,2-Tetrachloroethane	Volatile						2.4 mg/l (1)	170 ng/l**	10.7 ug/l**
1,1,2-Trichloroethane	Volatile						9.4 mg/l (1)	600 ng/l**	41.8 ug/l**
1,2-Dichloroethane	Volatile	5 ug/l		0 ug/l		118 mg/l (1)	20 mg/l (1)	940 ng/l**	243 ug/l**
1,2-Dichloroethene	Volatile								
1,2-Dichloropropane	Volatile		5 ug/l		0 ug/l	23 mg/l (1)	5.7 mg/l (1)		
2-Butanone	Volatile								
2-Hexanone	Volatile								
4-Methyl-2-pentanone	Volatile								
Acetone	Volatile								
Benzene	Volatile	5 ug/l		0 mg/l		5.3 mg/l (1)		660 ng/l**	40 ug/l**
Benzo(a)anthracene	Volatile								
Benzo(a)pyrene	Volatile								
Benzo(b)fluoranthene	Volatile								
Benzo(g,h,i)perylene	Volatile								
Benzo(k)fluoranthene	Volatile								
Bromodichloromethane	Volatile								
Bromoform	Volatile								
Bromomethane	Volatile								
Chlorinated Benzenes	Volatile					250 ug/l (1)	50 ug/l (1)		
Chlorobenzene	Volatile								
Chloroethane	Volatile								
Chloroform	Volatile	Tot THM <100 ug/l (2)				28.9 mg/l (1)	1.24 mg/l (4)	0.19 ug/l**	15.7 ug/l **

3-2.3

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Chloromethane	Volatile								
cis-1,3-Dichloropropene	Volatile					6.06 mg/l (1)	244 ug/l (1)	87 ug/l	14.1 mg/l
Dibromochloromethane	Volatile								
Ethyl Benzene	Volatile		0.7 mg/l		0.7 mg/l	32 mg/l (1)		1.4 mg/l	3.28 mg/l
Fluoranthene	Volatile					3.98 mg/l (1)		42 ug/l	54 ug/l
Haloethers	Volatile					380 ug/l (1)	122 ug/l (1)		
Halomethanes	Volatile					11 mg/l (1)		190 ng/l**	15.7 ug/l**
Indeno(1,2,3-cd)pyrene	Volatile								
Methylene Chloride	Volatile								
Phenanthrene	Volatile								
Phenol	Volatile					10.2 mg/l (1)	2.56 mg/l (1)	3.5 mg/l	
Polynuclear Aromatic Hydrocarbons	Volatile							2.8 ng/l**	31.1 ng/l**
Pyrene	Volatile								
Styrene	Volatile		0.1 mg/l		0.1 mg/l				
Tetrachloroethanes	Volatile					9.32 mg/l (1)			
Tetrachloroethene	Volatile		5 ug/l		0 ug/l	5.28 mg/l (1)	840 ug/l (1)	800 ng/l**	8.85 ug/l**
Total Xylenes	Volatile		10 mg/l		10 mg/l				
trans-1,3-Dichloropropene	Volatile					6.06 mg/l (1)	244 ug/l (1)	87 ug/l	14.1 mg/l
Trichloroethanes	Volatile		0.2 mg/l			18 mg/l (1)			
Trichloroethene	Volatile	5 ug/l		0 ug/l		45 mg/l (1)	21.9 mg/l (1)	2.7 ug/l**	80.7 ug/l**
Vinyl Acetate	Volatile								
1,2-Dichlorobenzene	Semi-Volatile		0.6 mg/l						
1,3-Dichlorobenzene (ortho)	Semi-Volatile		0.6 mg/l		0.6 mg/l				
1,4-Dichlorobenzene (para)	Semi-Volatile	75 ug/l		75 ug/l					
1,2,4-Trichlorobenzene	Semi-Volatile								
2-Chloronaphthalene	Semi-Volatile								
2-Chlorophenol	Semi-Volatile					4.36 mg/l (1)	2.0 mg/l (1)		
2-Methylnaphthalene	Semi-Volatile								

3-2.4

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA Water Quality Criteria for Protection of Human Health (c) Water and Fish Ingestion	CWA Water Quality Criteria for Protection of Human Health (c) Fish Consumption Only
2-Methylphenol	Semi-Volatile								
2-Nitroaniline	Semi-Volatile								
2-Nitrophenol	Semi-Volatile								
2,4-Dichlorophenol	Semi-Volatile					2.02 mg/l (1)	365 ug/l (1)	3.09 mg/l	
2,4-Dimethylphenol	Semi-Volatile					2.12 mg/l (1)			
2,4-Dinitrophenol	Semi-Volatile								
2,4-Dinitrotoluene	Semi-Volatile							110 ng/l**	9.1 ug/l**
2,4,5-Trichlorophenol	Semi-Volatile							2.8 mg/l	
2,4,6-Trichlorophenol	Semi-Volatile						970 ug/l (1)	1.2 ug/l**	3.6 ug/l**
3-Nitroaniline	Semi-Volatile								
3,3-Dichlorobenzidine	Semi-Volatile							0.01 ug/l	0.02 ug/l
4-Bromophenyl Phenylether	Semi-Volatile								
4-Chloroaniline	Semi-Volatile								
4-Chlorophenyl Phenyl Ether	Semi-Volatile								
4-Chloro-3-methylphenol	Semi-Volatile					30 ug/l (1)			
4-Methylphenol	Semi-Volatile								
4-Nitroaniline	Semi-Volatile								
4-Nitrophenol	Semi-Volatile					230 ug/l (1)	150 ug/l (1)		
4,6-Dinitro-2-methylphenol	Semi-Volatile								
Acenaphthene	Semi-Volatile					1.7 mg/l (1)	520 ug/l (1)		
Acetone	Semi-Volatile								
Acrylonitrile	Semi-Volatile								
Aldrin	Semi-Volatile					3.0 ug/l		0.074 ng/l	0.079 ng/l
Atrazine	Semi-Volatile		3 ug/l		3 ug/l				
Benzidine	Semi-Volatile								
Benzoic Acid	Semi-Volatile								
Benzyl Alcohol	Semi-Volatile								
bis(2-Chloroethoxy)methane	Semi-Volatile								
bis(2-Chloroethyl)ether	Semi-Volatile							30 ng/l**	1.36 ug/l **
bis(2-Chloroisopropyl)ether	Semi-Volatile							34.7 ug/l	4.36 mg/l

3-2.5

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
Parameter	Type					Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
bis(2-Ethylhexyl)phthalate	Semi-Volatile							15 mg/l	50 mg/l
Butyl Benzylphthalate	Semi-Volatile								
Carbon Disulfide	Semi-Volatile								
Carbon Tetrachloride	Semi-Volatile	5 ug/l		0 mg/l		35.2 mg/l (1)		400 ng/l**	6.94 ug/l**
Chlorinated Benzenes	Semi-Volatile					250 ug/l	50 ug/l		
Chlorinated Ethers	Semi-Volatile								
Chlorinated Napthalenes	Semi-Volatile					1.6 mg/l (1)			
Chloroalkylethers	Semi-Volatile					238 mg/l (1)			
Chlorodane	Semi-Volatile		2 ug/l			24 ug/l	4.3 pg/l	0.46 ng/l	0.48 ng/l
Chlorophenol	Semi-Volatile								
DDT	Semi-Volatile					1.1 ug/l	1 pg/l	24 pg/l	24 pg/l
DDE	Semi-Volatile					1.05 mg/l			
DDD	Semi-Volatile					0.05 ug/l			
Dichlorobenzidine	Semi-Volatile							0.01/ug/l	0.02 ug/l
Dibenzofuran	Semi-Volatile								
Dibenz(a,h)anthracene	Semi-Volatile								
Dichlorobenzenes	Semi-Volatile					1.12 mg/l (1)	763 ug/l (1)	400 ug/l	2.6 mg/l
Dichloroethenes	Semi-Volatile					11.6 mg/l (1)		33 ng/l**	1.85 ug/l**
Dichloromethane	Semi-Volatile								
Dieldrin	Semi-Volatile					2.5 ug/l	1.9 pg/l	0.07 ng/l	76 pg/l
Diethylphthalate	Semi-Volatile							350 mg/l	1.8 g/l
Dimethylphthalate	Semi-Volatile							313 mg/l	2.9 g/l
Di-n-butylphthalate	Semi-Volatile								
Dinitrotoluene	Semi-Volatile					330 ug/l (1)	230 ug/l (1)	70 ug/l	14.3 mg/l
Di-n-octylphthalate	Semi-Volatile								
Dioxin	Semi-Volatile					0.01 ug/l	10 pg/l	13 pg/l	14 pg/l
Endosulfan I	Semi-Volatile					0.22 ug/l	56 ng/l	74 ug/l	159 ug/l
Endosulfan II	Semi-Volatile								
Endosulfan Sulfate	Semi-Volatile								
Endrin	Semi-Volatile	0.2 ug/l				0.18 ug/l	2.3 ng/l	1 ug/l	

3-2.6

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA Water Quality Criteria for Protection of Human Health (c) Water and Fish Ingestion	CWA Water Quality Criteria for Protection of Human Health (c) Fish Consumption Only
Endrin Ketone	Semi-Volatile								
Fluorene	Semi-Volatile								
Halomethanes	Semi-Volatile	0.10 mg/l				11 mg/l		0.19 ug/l	15.7 ug/l
Heptachlor	Semi-Volatile		0.4 ug/l			0.52 ug/l	3.8 ng/l	0.28 ng/l	0.29 ng/l
Heptachlor Epoxide	Semi-Volatile		0.2 ug/l						
Hexachlorobenzene	Semi-Volatile							0.72 ng/l**	0.74 ng/l**
Hexachlorobutadiene	Semi-Volatile					90 ug/l (1)	9.3 ug/l (1)	450 ng/l**	50 ug/l**
Hexachlorocyclohexane, Alpha	Semi-Volatile							9.2 ng/l	31 ng/l
Hexachlorocyclohexane, Beta	Semi-Volatile							16.3 ng/l	54.7 ng/l
Hexachlorocyclohexane, (Lindane) Gama	Semi-Volatile	4 ug/l	0.2 ug/l		0.2 ug/l	2.0 ug/l	0.08 ug/l		
Hexachlorocyclohexane, Technical	Semi-Volatile							12.3 ng/l	41.4 ng/l
Hexachlorocyclopentadiene	Semi-Volatile					7 ug/l (1)	5.2 ug/l (1)	206 ug/l	
Hexachloroethane	Semi-Volatile					0.980 ug/l (1)	0.54 ug/l (1)	1.9 ug/l	8.74 ug/l
Isophorone	Semi-Volatile					117 mg/l (1)		5.2 mg/l	520 mg/l
Methoxychlor	Semi-Volatile	0.1 mg/l	0.04 mg/l		0.04 mg/l		0.03 ug/l	0.1 mg/l	
Naphthalene	Semi-Volatile					2.3 mg/l (1)	620 ug/l (1)		
Nitrobenzene	Semi-Volatile					27 mg/l (1)		19.8 mg/l	
Nitrophenols	Semi-Volatile					230 ug/l (1)	150 ug/l (1)		
Nitrosamines	Semi-Volatile					5.85 mg/l (1)			
Nitrosodibutylamine	Semi-Volatile							6.4 ng/l	587 ng/l
Nitrosodiethylamine	Semi-Volatile							0.8 ng/l	1.24 ug/l
Nitrosodimethylamine	Semi-Volatile							14 ng/l	16 ug/l
Nitrosopyrrolidine	Semi-Volatile							16 ng/l	91.9 ug/l
N-Nitrosodiphenylamine	Semi-Volatile							4.9 ug/l **	16.1 ug/l **
N-Nitroso-di-n-dipropylamine	Semi-Volatile								
PCBs	Semi-Volatile		0.5 ug/l			20 ug/l	14 ng/l	79 pg/l	79 pg/l
Pentachlorinated Ethanes	Semi-Volatile					7.24 mg/l (1)	1.1 mg/l (1)		
Pentachlorophenol	Semi-Volatile					20 ug/l (4)	13 ug/l (4)	1.01 mg/l	
Phthalate Esters	Semi-Volatile					940 ug/l (1)	3 ug/l (1)		
Simazine	Semi-Volatile								

3-2.7

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OU6, WALNUT CREEK PRIORITY DRAINAGE FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life (c)		CWA Water Quality Criteria for Protection of Human Health (c)	
						Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Toluene	Semi-Volatile	1 mg/l		1 mg/l		17.5 mg/l (1)		14.3 mg/l	424 mg/l
Toxaphene	Semi-Volatile		3 ug/l			0.73 ug/l	0.2 ng/l	0.71 ng/l	0.73 ng/l
Vinyl Chloride	Semi-Volatile	2 ug/l		0 ug/l			970 ug/l (1)	2 ug/l**	525 ug/l**

EXPLANATION OF TABLE

* = secondary maximum contaminant level
** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC = Ambient Water Quality Criteria
CWA = Clean Water Act
SDWA = Safe Drinking Water Act
SS = species specific

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR PArts 141, 142 and 143, Final Rule, effective July 30, 1992
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986

3-2.8

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcinogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Dissolved Oxygen	Field Parameter				5.0 mg/l	5.0 mg/l	3.0 mg/l				5.0 mg/l	5.0 mg/l		
pH	Field Parameter				6.5-9.0	6.5-9.0					6.5-9	6.5-9		
Specific Conductance	Field Parameter													
Temperature	Field Parameter				30 degrees	30 degrees								
Total Dissolved Solids	Indicator													
Bicarbonate	Anion													
Carbonate	Anion													
Chloride	Anion										3 ug/l	3 ug/l		
Fluoride	Anion													
N as Nitrate	Anion						100 mg/l				10 mg/l	10 mg/l		
N as Nitrate+Nitrite	Anion													
N as Nitrite	Anion				SS	SS	10 mg/l				1 mg/l	1 mg/l		
Potassium	Anion													
Sulfate	Anion										250 mg/l	250 mg/l		
Aluminum	Metal				950 ug/l	150 ug/l								
Antimony	Metal													
Arsenic	Metal				360 ug/l	150 ug/l	100 ug/l				50 ug/l			
Arsenic III	Metal													
Arsenic V	Metal													
Barium	Metal													
Beryllium	Metal						100 ug/l							
Cadmium	Metal				TVS	TVS	10 ug/l				TVS	TVS		
Calcium	Metal													
Chromium	Metal													
Chromium III	Metal				TVS	TVS	100 ug/l				50 ug/l			
Chromium VI	Metal				16 ug/l	11 ug/l	100 ug/l				TVS	TVS		
Cobalt	Metal													
Copper	Metal				TVS	TVS	200 ug/l				TVS	TVS		
Cyanide	Metal				5 ug/l	5 ug/l	200 ug/l				5 ug/l	5 ug/l		

3-3.1

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcin-ogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Iron	Metal					1 mg/l						300 ug/l (5)		
Lead	Metal				TVS	TVS	100 ug/l				TVS	TVS		
Magnesium	Metal													
Manganese	Metal					1 mg/l	200 ug/l					50 ug/l (5)		
Mercury	Metal				2.4 ug/l	0.1 ug/l						10 ng/l		
Molybdenum	Metal													
Nickel	Metal				TVS	TVS	200 ug/l				TVS	TVS		
Selenium	Metal				135 ug/l	17 ug/l	20 ug/l				10 ug/l			
Silver	Metal				TVS	TVS					TVS	TVS		
Sodium	Metal													
Thallium	Metal					15 ug/l								
Tin	Metal													
Titanium	Metal													
Tungsten	Metal													
Vanadium	Metal													
Zinc	Metal				TVS	TVS	2.0 mg/l				TVS	TVS		
Americium	Radionuclide									30 pCi/l			0.05 pCi/l	0.05 pCi/l
Americium 241	Radionuclide													
Cesium 137	Radionuclide									80 pCi/l			80 pCi/l	80 pCi/l
Cesium 134	Radionuclide												7 pCi/l	11 pCi/l
Gross Alpha	Radionuclide												5 pCi/l	19 pCi/l
Gross Beta	Radionuclide												0.05 pCi/l	0.05 pCi/l
Plutonium	Radionuclide									15 pCi/l				
Plutonium 238+239+240	Radionuclide									5 pCi/l				
Radium 226+228	Radionuclide									8 pCi/l			8 pCi/l	8 pCi/l
Strontium 90	Radionuclide									60 pCi/l				
Thorium 230+232	Radionuclide									20,000 pCi/l			500 pCi/l	500 pCi/l
Tritium	Radionuclide													
Uranium 233+234	Radionuclide													

3-3.2

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcinogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Uranium 235	Radionuclide													
Uranium 238	Radionuclide													
Uranium (total)	Radionuclide									40 pCi/l			5 pCi/l	10 pCi/l
1,1-Dichloroethane	Volatile													
1,1-Dichloroethene	Volatile	7 ug/l						7 ug/l						
1,1,1-Trichloroethane	Volatile	200 ug/l						200 ug/l						
1,1,2,2-Tetrachloroethane	Volatile			2.4 mg/l					170 ng/l			170 ng/l		
1,1,2-Trichloroethane	Volatile	28 ug/l (6)		9.4 mg/l				28 ug/l (6)	600 ng/l			600 ng/l		
1,2-Dichloroethane	Volatile	5 ug/l	118 mg/l	20 mg/l				5 ug/l						
1,2-Dichloroethene	Volatile	70 ug/l						70 ug/l						
1,2-Dichloropropane	Volatile	560 ng/l	23 mg/l	5.7 mg/l				560 ng/l						
2-Butanone	Volatile													
2-Hexanone	Volatile													
4-Methyl-2-pentanone	Volatile													
Acetone	Volatile													
Benzene	Volatile	5 ug/l						5 ug/l						
Benzo(a)anthracene	Volatile													
Benzo(a)pyrene	Volatile													
Benzo(b)fluoranthene	Volatile													
Benzo(g,h,i)perylene	Volatile													
Benzo(k)fluoranthene	Volatile													
Bromodichloromethane	Volatile													
Bromoform	Volatile													
Bromomethane	Volatile													
Chlorinated Benzenes	Volatile													
Chlorobenzene	Volatile	300 ug/l						300 ug/l						
Chloroethane	Volatile													
Chloroform	Volatile	Tot THM < 100 ug/l (4)	28.9 mg/l	1.24 mg/l				Tot THM < 100 ug/l (4)	0.19 ug/l			0.19 ug/l		

3-3.3

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcinogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Chloromethane	Volatile													
cis-1,3-Dichloropropene	Volatile													
Dibromochloromethane	Volatile													
Ethyl Benzene	Volatile	680 ug/l	32 mg/l					680 ug/l						
Fluoranthene	Volatile		3.98 mg/l											
Haloethers	Volatile													
Halomethanes	Volatile								190 ng/l			190 ng/l		
Indeno(1,2,3-cd)pyrene	Volatile													
Methylene Chloride	Volatile													
Phenanthrene	Volatile													
Phenol	Volatile													
Polynuclear Aromatic Hydrocarbons	Volatile								2.8 ng/l			2.8 ng/l		
Pyrene	Volatile													
Styrene	Volatile													
Tetrachloroethanes	Volatile													
Tetrachloroethene	Volatile	10 ug/l	5.28 mg/l	840 ug/l				10 ug/l	800 ng/l					
Total Xylenes	Volatile													
trans-1,3-Dichloropropene	Volatile													
Trichloroethanes	Volatile													
Trichloroethene	Volatile	5 ug/l	45 mg/l	21.9 mg/l				5 ug/l						
Vinyl Acetate	Volatile													
1,2-Dichlorobenzene	Semi-Volatile	620 ug/l						620 ug/l						
1,3-Dichlorobenzene	Semi-Volatile	620 ug/l						620 ug/l						
1,4-Dichlorobenzene	Semi-Volatile	75 ug/l						75 ug/l						
1,2,4-Trichlorobenzene	Semi-Volatile													
2-Chloronaphthalene	Semi-Volatile													
2-Chlorophenol	Semi-Volatile													
2-Methylnaphthalene	Semi-Volatile													

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcin-ogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
2-Methylphenol	Semi-Volatile													
2-Nitroaniline	Semi-Volatile													
2-Nitrophenol	Semi-Volatile													
2,4-Dichlorophenol	Semi-Volatile	21 ug/l	2.02 mg/l	365 ug/l				21 ug/l						
2,4-Dimethylphenol	Semi-Volatile													
2,4-Dinitrophenol	Semi-Volatile													
2,4-Dinitrotoluene	Semi-Volatile													
2,4,5-Trichlorophenol	Semi-Volatile	700 ug/l (6)						700 ug/l (6)						
2,4,6-Trichlorophenol	Semi-Volatile	2.0 ug/l (6)		970 ug/l				2.0 ug/l (6)	1.2 ug/l			1.2 ug/l		
3-Nitroaniline	Semi-Volatile													
3,3-Dichlorobenzidine	Semi-Volatile								10 ng/l					
4-Bromophenyl Phenylether	Semi-Volatile													
4-Chloroaniline	Semi-Volatile													
4-Chlorophenyl Phenyl Ether	Semi-Volatile													
4-Chloro-3-methylphenol	Semi-Volatile													
4-Methylphenol	Semi-Volatile													
4-Nitroaniline	Semi-Volatile													
4-Nitrophenol	Semi-Volatile													
4,6-Dinitro-2-methylphenol	Semi-Volatile													
Acenaphthene	Semi-Volatile		1.7 mg/l	520 ug/l										
Acetone	Semi-Volatile													
Acrylonitrile	Semi-Volatile		7.55 mg/l	2.6 mg/l					58 mg/l			58 mg/l		
Aldrin	Semi-Volatile	2 ng/l	3 ug/l					2 ng/l	74 pg/l			74 pg/l		
Anthracene	Semi-Volatile													
Atrazine	Semi-Volatile											3 ug/l		
Benzidine	Semi-Volatile	0.2 ng/l	2.5 mg/l					0.2 ng/l	0.12 ng/l			0.12 ng/l		
Benzoic Acid	Semi-Volatile													
Benzyl Alcohol	Semi-Volatile													
bis(2-Chloroethoxy)methane	Semi-Volatile													
bis(2-Chloroethyl)ether	Semi-Volatile	30 ng/l (6)						30 ng/l (6)				0.0037 ng/l		

3-3.5

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B	Table C	Table D	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type	Carcinogenic/ Noncarcinogenic (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	(2)	Fish & Water Ingestion	Radionuclide Standards	Acute Value	Chronic Value	Woman Ck.	Walnut Ck
bis(2-Chloroisopropyl)ether	Semi-Volatile													
bis(2-Ethylhexyl)phthalate	Semi-Volatile													
Butyl Benzylphthalate	Semi-Volatile													
Carbon Disulfide	Semi-Volatile													
Carbon Tetrachloride	Semi-Volatile	5 ug/l	35.2 mg/l					5 ug/l						
Chlorinated Benzenes	Semi-Volatile													
Chlorinated Ethers	Semi-Volatile													
Chlorinated Napthalenes	Semi-Volatile													
Chloroalkylethers	Semi-Volatile													
Chlorodane	Semi-Volatile	30 ng/l	2.4 ng/l	4.3 ng/l				0.03 ug/l	0.46 ng/l			0.46 ng/l		
Chlorophenol	Semi-Volatile													
DDT	Semi-Volatile	0.1 ug/l	1.1 ug/l	1.0 ng/l				0.1 ug/l	24 pg/l			24 pg/l		
DDE	Semi-Volatile		1.05 mg/l											
DDD	Semi-Volatile		0.6 ug/l									0.01 ug/l		
Dichlorobenzidine	Semi-Volatile													
Dibenzofuran	Semi-Volatile													
Dibenz(a,h)anthracene	Semi-Volatile													
Dichlorobenzenes	Semi-Volatile													
Dichloroethenes	Semi-Volatile													
Dichloromethane	Semi-Volatile													
Dieldrin	Semi-Volatile	2 ng/l	2.5 ug/l	1.9 ng/l				2 ng/l	71 pg/l			71 pg/l		
Diethylphthalate	Semi-Volatile													
Dimethylphthalate	Semi-Volatile													
Di-n-butylphthalate	Semi-Volatile													
Dinitrotoluene	Semi-Volatile													
Di-n-octylphthalate	Semi-Volatile													
Dioxin	Semi-Volatile	0.22 pg/l	0.01 ug/l	0.01 ng/l				0.22 pg/l	13 fg/l			13 fg/l		
Endosulfan I	Semi-Volatile		0.22 ug/l	0.056 ug/l										
Endosulfan II	Semi-Volatile													
Endosulfan Sulfate	Semi-Volatile													

3-3.6

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE
STATE SURFACE WATER QUALITY STANDARDS

		Statewide Standards (a) CDH/WQCC						Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC						
		Tables A,B Carcinogenic/ Noncarcinogenic (2)	Table C Aquatic Life		Tables I,II,III (1)			Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide Standards	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)				Acute Value	Chronic Value	Woman Ck.	Walnut Ck
Endrin	Semi-Volatile	0.2 ug/l	0.18 ug/l	2.3 ng/l				0.2 ug/l						
Endrin Ketone	Semi-Volatile													
Fluorene	Semi-Volatile													
Halomethanes	Semi-Volatile	100 ug/l						0.1 mg/l	0.19 ug/l			0.19 ug/l		
Heptachlor	Semi-Volatile	8 ng/l	0.52 ug/l	3.8 ng/l				8 ng/l	0.28 ng/l			0.28 ng/l		
Heptachlor Epoxide	Semi-Volatile	4 ng/l						4 ng/l						
Hexachlorobenzene	Semi-Volatile	0.02 ug/l						0.02 ug/l	0.72 ng/l			0.72 ng/l		
Hexachlorobutadiene	Semi-Volatile	14 ug/l (6)	90 ug/l	9.3 ug/l				14 ug/l	0.45 ng/l			0.45 ng/l		
Hexachlorocyclohexane, Alpha	Semi-Volatile								9.2 ng/l			9.2 ng/l		
Hexachlorocyclohexane, Beta	Semi-Volatile								16.3 ng/l			16.3 ng/l		
Hexachlorocyclohexane, (Lindane) Gamma	Semi-Volatile	4 ug/l	2.0 ug/l	80 ng/l				4 ug/l	18.6 ng/l			18.6 ng/l		
Hexachlorocyclohexane, Technical	Semi-Volatile											12.3 ng/l		
Hexachlorocyclopentadiene	Semi-Volatile	49 ug/l (6)	7 ug/l	5.2 ug/l				49 ug/l						
Hexachloroethane	Semi-Volatile		0.98 ug/l	0.54 ug/l					1.9 ug/l			1.9 ug/l		
Isophorone	Semi-Volatile	1.05 mg/l (6)	117 mg/l					1.05 mg/l						
Methoxychlor	Semi-Volatile	100 ug/l		0.03 ug/l				0.1 mg/l						
Naphthalene	Semi-Volatile		2.3 mg/l	620 ug/l										
Nitrobenzene	Semi-Volatile	3.5 ug/l (6)	27 mg/l					3.5 ug/l						
Nitrophenols	Semi-Volatile													
Nitrosamines	Semi-Volatile													
Nitrosodibutylamine	Semi-Volatile								6.4 ng/l			6.4 ng/l		
Nitrosodiethylamine	Semi-Volatile								0.8 ng/l			0.8 ng/l		
Nitrosodimethylamine	Semi-Volatile								1.4 ng/l			1.4 ng/l		
Nitrosoplyrrolidine	Semi-Volatile								16 ng/l			16 ng/l		
N-Nitrosodiphenylamine	Semi-Volatile								4.9 ug/l			4.9 ug/l		
N-Nitroso-di-n-dipropylamine	Semi-Volatile													
PCBs	Semi-Volatile	5 ng/l	2.0 ug/l	14 ng/l				5 ng/l	79 pg/l			79 pg/l		
Pentachlorinated Ethanes	Semi-Volatile													
Pentachlorophenol	Semi-Volatile	200 ug/l	9 ug/l	5.7 ug/l				200 ug/l						
Phthalate Esters	Semi-Volatile													

3-3.7

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARS/TBCs, OU6 WALNUT CREEK PRIORITY DRAINAGE STATE SURFACE WATER QUALITY STANDARDS

Parameter	Type	Statewide Standards (a) CDH/WQCC: Tables A,B Carcinogenic/ Noncarcinogenic (2)	Statewide: Table C Aquatic Life: Acute Value	Statewide: Table C Aquatic Life: Chronic Value	Statewide: Tables I,II,III (1): Acute Value (2)	Statewide: Tables I,II,III (1): Chronic Value (2)	Statewide: Tables I,II,III (1): Agricultural Standard (3)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7) CDH/WQCC: Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radionuclide Standards	Segment 4 & 5: Stream Segment Table (8): Acute Value	Segment 4 & 5: Stream Segment Table (8): Chronic Value	Segment 4 & 5: Table 2 Radionuclides: Woman Ck.	Segment 4 & 5: Table 2 Radionuclides: Walnut Ck
Simazine	Semi-Volatile											4 ug/l		
Toluene	Semi-Volatile	2.42 mg/l	17.5 mg/l					2.42 mg/l						
Toxaphene	Semi-Volatile	5 ug/l		0.73 ug/l	0.2 ng/l			5 ug/l						
Vinyl Chloride	Semi-Volatile	2 ug/l						2 ug/l						

EXPLANATION OF TABLE

CDH = Colorado Department of Health
SS = species specific
TVS = Table Value Standard (hardness dependent), see Table III in (a)
WQCC = Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(5) Lowest value given: dissolved or total recoverable
(6) Based on 10E-6 cancer risk from EPA Integrated Risk Information System
(7) Segment 4 standards are ARARs and Segment 5 standards are goals (TBCs)
(8) Includes Table 1: Additional Organic Chemical Standards (chronic only)

(a) CDH/WQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989 (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/WQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990

3-3.8

action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." The most stringent promulgated standards are applied as ARAR (Preamble to NCP, 55 FR 8741).

3.2.2 TBCs

In addition to applicable or relevant and appropriate requirements, advisories, criteria, or guidance may be identified as TBC for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category consists of advisories, criteria, or guidance developed by EPA, other federal agencies, or states that may be useful in developing remedies. Use of TBCs is discretionary rather than mandatory, as is the case with ARARs.

3.2.3 ARAR Categories

In general, there are three categories of ARARs:

1. Ambient or chemical-specific requirements

2. Location-specific requirements

3. Performance, design, or other action-specific requirements

ARARs are generally considered to be dynamic in nature in that they evolve from general to very specific in the CERCLA site cleanup process. Initially, during the RI work plan stage, probable chemical-specific ARARs may be identified, usually based on a limited amount of data. Chemical-specific ARARs at this point have meaning only in that they may be used to ensure appropriate detection limits have been established so that data collected in the RI will be amenable for comparison to ARAR standards. It is also appropriate to identify location-specific ARARs early in the RI process so that information may be gathered to determine if restrictions may be placed on the concentration of hazardous substances or on the conduct of an activity solely because it occurs in a special location.

Chemical-specific ARARs do not currently exist for soils. As the remedial investigation proceeds, information will become available from the risk assessment which will allow a determination of acceptable contaminant concentrations in soils to ensure environmental "protectiveness."

3.2.4 Feasibility Study ARAR Requirements

Development of a preliminary list of potential chemical-specific ARARs in the RI process also allows the establishment of a list of preliminary remediation goals in the early FS process, which is essentially a tentative listing of contaminants together with initially anticipated cleanup concentrations or risk levels for each medium. Preliminary remediation goals serve to focus the development of alternatives on remedial technologies that can achieve the remediation goals, thereby limiting the number of alternatives to be considered in the detailed remedial alternative analysis, conducted later in the FS process. As more information becomes available during the RI stage, chemical-specific ARARS may become more refined as constituents are added or deleted, which is often the case when the RI takes place in numerous phases. Once data collection is complete, revised chemical-specific ARAR selection may be proposed.

When the data collection is complete, it is also appropriate to refine location-specific ARARs which may affect the development of remedial alternatives. During development of remedial action alternatives at the beginning of the FS process, a preliminary consideration of action-specific ARARs will be conducted. As remedial alternatives are screened during the FS, action-specific ARARs will be identified. When a detailed analysis of the remedial alternatives is conducted, all action-specific ARARs are refined and finalized with respect to each alternative before a comparison of alternatives begins. At this point, a discussion is provided in the FS report for each remedial alternative regarding the rationale for all ARAR determinations.

3.2.5 Remedial Action

CERCLA §121 specifically requires attainment of all ARARs. Moreover, as explained in the preamble to the National Contingency Plan (NCP) (55 FR 8741), in order to attain all ARARs, a remedial action must comply with the most stringent requirement, which then ensures attainment of all other ARARs. Furthermore, CERCLA requires that the remedies selected attain ARARs and be protective of human health and the environment. Consequently, preliminary remediation goals based on ARARs will require modification as new information and data are collected in the RI, including the baseline risk assessment (to be conducted), when ARARs are not available or are determined to be inadequate for protection of human health and the environment.

3.2.6 Remediation Goals

Development of remediation goals is actually a portion of the overall development of remedial action objectives, which ultimately will define the required endpoint of the selected remedial action. As stated in the preamble to the NCP (55 FR 8713), "remedial action objectives are the more general description of what the remedial action will accomplish. Remediation goals are a subset of remedial action objectives and consist of medium-specific or operable unit-specific chemical concentrations that are protective of human health and the environment and serve as goals for the remedial action. The remedial action objectives ... should specify: (1) the contaminants of concern, (2) exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure medium (i.e., a preliminary remediation goals)." According to 40 CFR 300.430 (e)(2)(i), "Remediation goals shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following:

(A) ARARs (chemical-specific) and

- (1) Acceptable exposure levels for systemic toxicants,
- (2) Acceptable exposure levels for known or suspected carcinogens,
- (3) Technical limitations (e.g., detection limits),
- (4) Uncertainty factors, and
- (5) Other pertinent information.

(B) Maximum Contaminant Level Goals (MCLGs) (or Maximum Contaminant Levels -- MCLs -- where MCLGs are zero or where MCLGs are not relevant and appropriate), where relevant and appropriate.

(C) Acceptable exposure levels where multiple contaminants or multiple exposure pathways will cause exposure at ARAR levels will result in cumulative risk in excess of 10^{-4}.

(D) Clean Water Act (CWA) Water Quality Criteria, where relevant and appropriate.

(E) A CERCLA Alternative Concentration Limit (ACL) established pursuant to CERCLA § 121(d)(2)(B)(ii).

(F) Environmental evaluations, performed to assess specific threats to the environment.

Once a remedial action alternative is formally selected, all chemical-, location-, and action-specific ARARs will be defined in final form. If it is found that the most suitable remedial alternative does not meet an ARAR, the NCP, at 40 CFR 300.430 (f)(1)(ii)(C), provides for waivers of ARARs under certain circumstances, such as technical impracticability, risk, or inconsistent application of state requirements. From this point, the alternative will become the final remedy as it is incorporated into the Record of Decision (ROD). Once the final ROD has been signed, requirements may be modified only when they are determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment (40 CFR 300.430(f)(1)(ii)).

The primary objective of a RCRA Facility Investigation (RFI)/Remedial Investigation (RI) is to collect the data necessary to determine the nature, distribution, and migration pathways of contaminants. This information will be used to support a baseline risk assessment and environmental assessment. These assessments determine the need for remediation and are used to evaluate remedial alternatives. Five general goals of a RFI/RI (EPA 1988a) are to

- Characterize site physical features
- Define contaminant sources
- Determine the nature and extent of contamination
- Describe contaminant fate and transport
- Provide a baseline risk assessment

Data quality objectives (DQOs) are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI (U.S. EPA 1987a). The DQO process is divided into three stages:

- Stage 1 - Identify decision types
- Stage 2 - Identify data uses/needs
- Stage 3 - Design data collection program

Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving those goals. This section of the RFI/RI Work Plan proceeds through the DQO process.

4.1 STAGE 1 - IDENTIFY DECISION TYPES

4.1.1 Identify and Involve Data Users

Data users are the decision makers and the primary and secondary data users. The decision makers for OU6 are the management and regulatory personnel of EG&G, the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH). EG&G's contractor will provide day-to-day management of the RI in accordance with this work plan. The decision makers have been and are involved in the OU6 DQO process through the Interagency Agreement (IAG), which specifies the minimum level of effort for the Phase I RI. The decision makers remain involved through the review and approval process specified in the IAG.

Primary data users are those individuals involved in ongoing RI activities. These are EG&G and EG&G's subcontractor technical staffs. They will be involved in the collection and analysis of the data and in the preparation of the RI Report, including the Baseline Risk Assessment and the Environmental Assessment.

Secondary data users are those users that rely on RI outputs to support their activities. Secondary data users may include EG&G and EG&G subcontractor personnel working on other operable units or sitewide projects, EPA and CDH.

4.1.2 Evaluate Available Data

The historical and current conditions of each site are described in Section 2.0 of this work plan.

The following is a summary of the existing information based on the data presented in Section 2.0.

- Only a portion of the data collected to date have been validated and there are some uncertainties in the unvalidated data.
- Contamination by radioactive materials is known or suspected to exist at all of the IHSSs in OU6. Contamination also occurs in Walnut Creek.
- Little information is available, excluding Walnut Creek and the detention ponds, concerning metals contamination, if any, in these IHSSs.
- Contamination, if any, due to other substances is unknown at this time for most of the IHSSs.
- The extent of contamination, if any, at the IHSSs in OU6 is unknown at this time.
- The presence of contamination is uncertain in the Old Outfall area (IHSS 143). Investigations should focus on confirming the presence or absence of contamination.
- There appears to be a potential for contamination from topographically or hydraulically upgradient or upwind sources (i.e., other operable units) to be present at the IHSSs.

4.1.3 Develop Conceptual Models

Conceptual models have been developed for each IHSS in subsection 2.11. These models include a description of potential sources, pathways and receptors. Since very few previous studies have been conducted at OU6, the models are basic Phase I models. It is not known if the sources or pathways actually exist at many of the IHSSs. Figure 4-1 presents a schematic Phase I conceptual model for the trenches or Triangle Area, which are buried potential sources. Figure 4-2 presents a schematic Phase I conceptual model for potential surface sources such as Walnut Creek, the spray fields, or the surface dispersal area.

4.1.4 Specify Phase I RFI/RI Objectives and Data Needs

Based on existing data and the IHSS conceptual models, site-specific Phase I RFI/RI objectives/data needs associated with identifying contaminant sources and the nature and extent of contamination are shown in Table 4-1.

The objectives of the Phase I RFI/RI are:

- To characterize the physical and hydrogeologic setting of the IHSSs
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs.

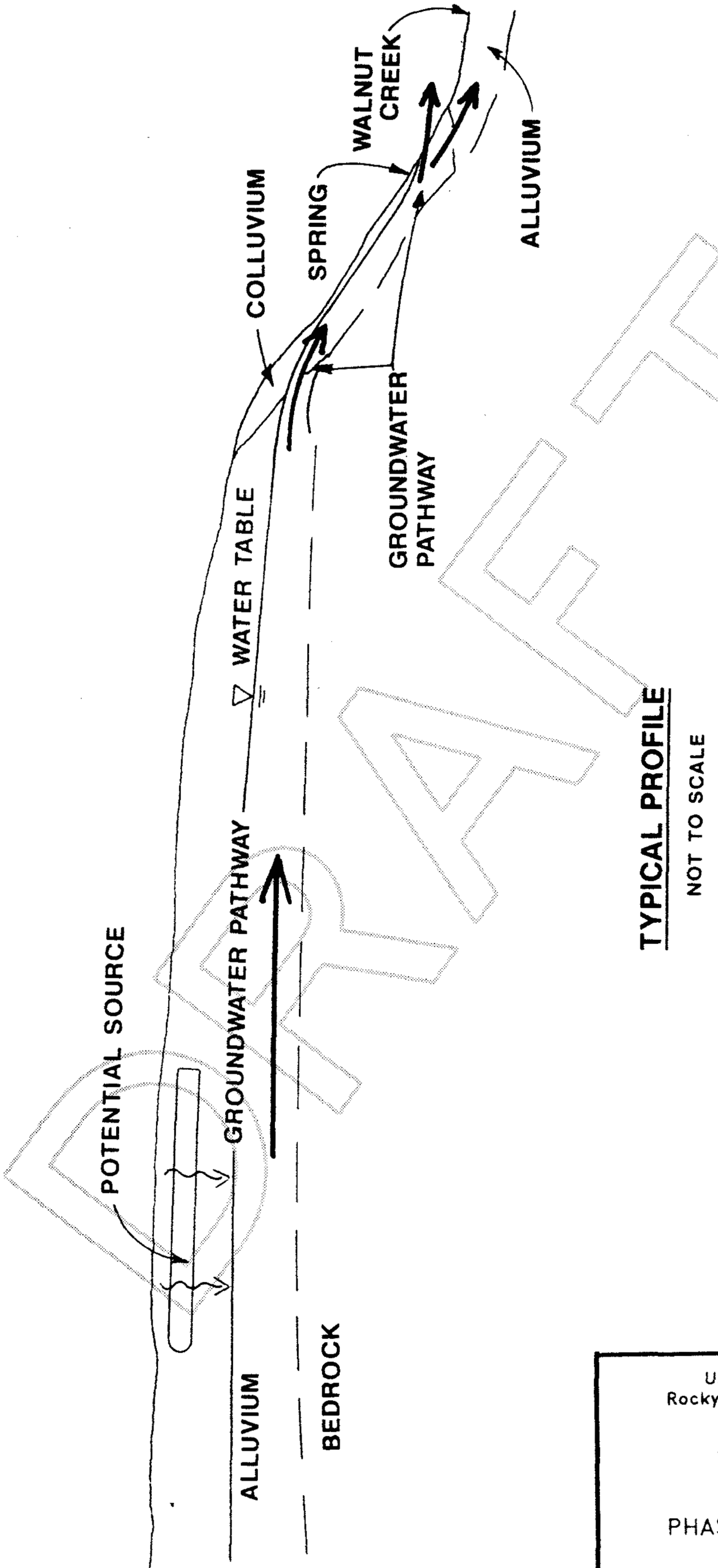
4.2 STAGE 2 - IDENTIFY DATA USES/NEEDS

Stage 2 of the DQO process defines data uses and specifies the types of data needed to meet the project objectives. The summary of Stage 2 of the DQO process is presented as Table 4-1.

4.2.1 Identify Data Uses

RI/FS data uses can be described in the following general purpose categories:

- Site characterization
- Health and safety
- Risk Assessment
- Evaluation of alternatives
- Engineering design of alternatives



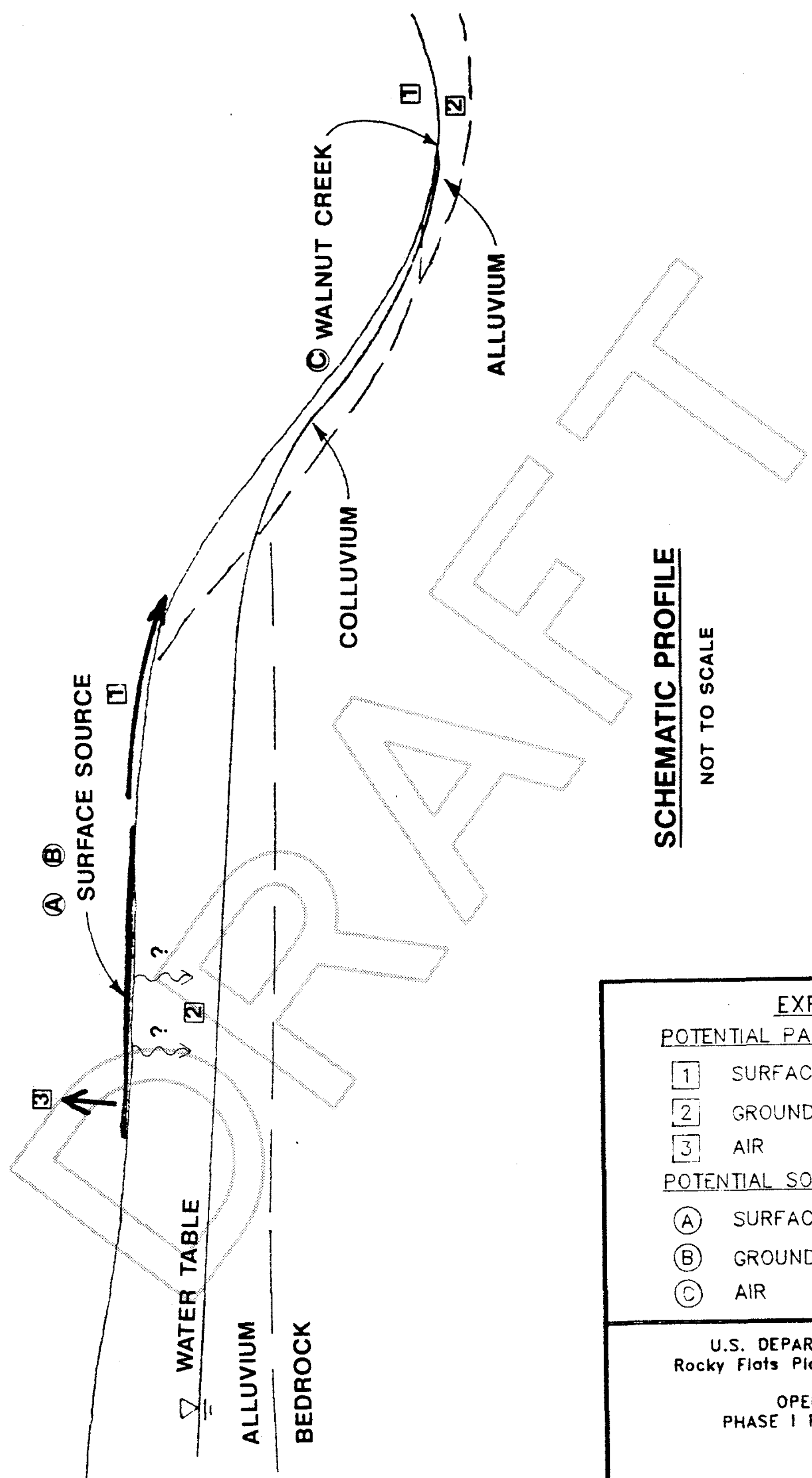
TYPICAL PROFILE
NOT TO SCALE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PHASE 1 CONCEPTUAL MODEL
FOR TRENCHES OR
TRIANGLE AREA

FIGURE 4-1 APRIL 1991



EXPLANATION

POTENTIAL PATHWAYS

1 SURFACE WATER/SEDIMENT

2 GROUNDWATER

3 AIR

POTENTIAL SOURCES

Ⓐ SURFACE WATER

Ⓑ GROUNDWATER

Ⓒ AIR

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PHASE I CONCEPTUAL MODEL
SURFACE SOURCES AND
WALNUT CREEK

FIGURE 4-2 APRIL 1991

TABLE 4-1

DATA QUALITY OBJECTIVES

Data Need	Sample/Analysis Activity	Analytical Level	Data Use
CHARACTERIZE PHYSICAL FEATURES			
• Identify extent of the spray fields, trenches, Old Outfall, Soil Dump Area, and Triangle Area.	• Review aerial photographs • Visual inspection • Logging of boreholes	I & II	• Site Characterization • Alternatives Evaluation
• Characterize surface water and sediments in the ponds	• Logging of sediment samples • Measurement of field parameters in water in the ponds	I & II	• Site Characterization • Alternatives Evaluation
• Locate and delineate extent of the trenches	• Geophysical survey	I & II	• Site Characterization • Alternatives Evaluation
CHARACTERIZE AND DELINEATE CONTAMINANT SOURCES			
• Identify plumes (if present) at the Triangle Area	• Soil gas survey • Boreholes and wells with analytical testing on samples, if plumes are identified	II (field GC) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize sources (if present) at the Trenches and Old Outfall	• Boreholes and surface samples in areas of trenches and outfall with analytical testing of samples	I & II (field) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment
CHARACTERIZE NATURE AND EXTENT OF CONTAMINATION			
• Characterize plumes or hotspots identified at the Triangle Area	• Boreholes and wells with analytical testing of samples, if plumes are identified	IV and V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize horizontal and vertical extent and nature of contamination at the spray fields, trenches, Triangle Area, Soil Dump Area, and Old Outfall	• Boreholes and wells with analytical testing of samples	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment

TABLE 4-1

DATA QUALITY OBJECTIVES
(Concluded)

Data Need	Sample/Analysis Activity	Analytical Level	Data Use
• Characterize extent of radiative materials at Triangle Area, Old Outfall, and Sludge Dispersal area	• Radiation surveys	I & II	• Site Characterization • Health and Safety
• Characterize nature and extent of contamination in surface water and sediments in Walnut Creek	• Sediment and surface water sampling with analytical testing of the samples	II (field) IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize nature and extent of contamination in alluvial groundwater	• Install and sample wells	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize the lateral extent of Sludge Dispersal area	• Surface soil samples with analytical testing	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment

- Monitoring during remedial action
- PRP determination

Since this work plan describes a Phase I RI, data uses such as engineering design and monitoring during remediation (both remedial action activities) will not be considered. The data use for PRP determination is also not appropriate to this work plan. The remaining four data uses will be important in meeting the objectives identified in subsection 4.1.4.

4.2.2 Identify Data Types

Data types can be specified in broad groups initially and then divided into more specific components. For the Phase I investigation, soil, sediment, groundwater and surface water samples will be collected. In addition, radiation surveys will be conducted over some of the units. These data types will provide broad Phase I information regarding the presence or absence of contamination at the units. Selection of chemical analyses and physical testing will be based on the objectives of the Phase I program and on the past activities at the units. Data types are listed on Table 4-1 as sample/analysis methods.

4.2.3 Identify Data Quality Needs

EPA defines five levels of analytical data as follows (U.S. EPA 1987a):

- Level I - field screening or analysis using portable instruments. Results are often not compound specific and not quantitative but results are available in real-time. It is the least costly of the analytical options.

- Level II - field analyses using more sophisticated portable analytical instruments: in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, and sample preparation equipment; and the training of the operator. Results are available in real-time or several hours.

- Level III - all analyses performed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory.

- Level IV - CLP routine analytical services (RAS). All analyses are performed in an off-site CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP special analytical services (SAS) are Level V.

The levels appropriate to the data need and data use have been specified on Table 4-1 for each data need. The levels as they apply to this work plan and specific analyses are presented in Table 4-2.

4.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on the quantities specified in the IAG. The Phase I data will be evaluated to determine the appropriate number of samples to be obtained in subsequent phases of the RI.

4.2.5 Evaluate Sampling/Analysis Options

The sampling/analysis approach for this Phase I work plan is based on a stepped, or phased approach. Screening level sampling and analysis is followed by sampling of hotspots or other areas identified during screening. Where no data are available, a grid system will be used.

4.2.6 Review PARCC Parameter Information

PARCC (precision, accuracy representativeness, completeness and comparability) parameters are indicators of data quality. Precision, accuracy and completeness goals are established for this work plan based on the analyses being performed and the analytical levels. PARCC goals are specified in the Quality Assurance Addendum (QAA) in Section 10.0 of this work plan.

4.3 STAGE 3 - DESIGN DATA COLLECTION PROGRAM

The purpose of Stage 3 of the DQO process is to design the specific data program for the Phase I Walnut Creek drainage RI. To accomplish this, the elements identified in Stages 1 and 2 and the IAG were assembled, and the Sampling and Analysis Plan (SAP) was prepared. The SAP consists of a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPjP). These two components are presented in Sections 7.0 and 10.0 of this work plan.

TABLE 4-2

LEVEL OF ANALYSIS

Required Analytical Level	Task
Level I (Field Screens)	• Water level measurement • pH measurement • Screening for organics (OVA/HNu) • Screening for radionuclides (beta-gamma) • Temperature • Specific conductance • Geophysical surveys
Level II (Field Analyses)	• Screening for organics (GC) • Screening for radionuclides (gross beta/gross alpha, gamma spec) • Analysis of engineering properties
Level III (Laboratory Analyses using EPA Standard Methods)	• Major ion analysis • Organics analysis • Inorganics analysis
Level IV (Laboratory Analyses using EPA CLP Methods)	• Analysis of Target Compound List (TCL) and Target Analyte List (TAL)
Level V (Nonstandard Analyses)	• Radiological analyses • Chemical analyses requiring modification of standard methods • Special Analytical Services (SAS)

Source: U.S. EPA (1987a)

5.0
PHASE I RCRA FACILITY INVESTIGATION/ REMEDIAL INVESTIGATION TASKS

5.1 TASK 1 - PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the Walnut Creek drainage. Activities undertaken for this project have included a review of previous investigations results, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which becomes available after preparation of this work plan. The Interagency Agreement (IAG) also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

Available aerial photographs will be reviewed again to assess the types and extent of activities at several of the IHSSs. A discussion of the aerial photograph review for each unit is included as the Step 1 work for each unit in Section 7.0 of this document. Available reports and Plant plans will also be reviewed. The findings of the aerial photo review and the records review will be used to finalize the field investigation program.

There are ongoing site studies at Rocky Flats of surface water and sediments, groundwater, geology (EG&G 1990c), background geochemistry (EG&G 1990b), and ambient air that may provide data that have bearing on investigations in Walnut Creek. These data will be compiled and evaluated during Task 1. For example, the need for additional surface water and sediment sampling locations will be dependent on the locations of ongoing sampling and the scope of analyses. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 7.0 need not be collected again.

Other project-related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPjP) and Standard Operating Procedures (SOP) for field activities, is being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) for the Phase I investigation is included as Section 7.0 of this document. The FSP will be revised as necessary based on the findings of the photo and historical records review.

5.2 TASK 2 - COMMUNITY RELATIONS

The information contained in this section is summarized from DOE (1990b). In accordance with the IAG dated January 22, 1991, the Communications Department at Rocky Flats is developing a Plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A Draft Community Relations Survey Plan has been completed and forwarded to the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the public for review. This plan specifies activities planned to complete the Environmental Restoration (ER) Program CRP, including plans for community interviews. The draft CRP was completed in September and the final CRP in November 1990, in accordance with the IAG schedules. Accordingly, a site-specific CRP is not required for Operable Unit Number 6 (OU6). The ER Program community relations activities include participation by Plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings for the public on proposed remedial action plans, and meetings to solicit public comment on various ER Program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed of ER activities and other issues related to Plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which Plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department receives numerous public inquiries, which are answered through telephone conversations or by sending written informational materials to the requestor.

5.3 TASK 3 - FIELD INVESTIGATION

Phase I field investigations will be conducted at all of the IHSSs in Walnut Creek to collect samples and data concerning the nature and extent of contamination, if any, at each unit. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Baseline Risk Assessment, as well as meet the objectives and data needs described in Section 4.0 of this Work Plan. It is important to recognize that additional Phases of investigation and risk assessment may be required at some IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys, geophysical surveys, and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, surface water sampling and sediment sampling. Wells will be installed at specified locations and in some test borings.

Twenty-one individual IHSSs have been included in OU6 in the Walnut Creek drainage. These IHSSs have been grouped into seven groups based on the historical use of the units and the physical similarities of the units. The group numbers are used in the maps, figures and tables to describe each of the units. Because of the diverse nature of the IHSS groups, the Phase I field investigations of each group will be different. The general discussion of field activities for each IHSS group, based on the IAG, is given below. Specific field activities are described in the Phase I FSP in Section 7.0 of this work plan.

5.3.1 IHSS 141 - Sludge Dispersal Area

The screening activity at the sludge dispersal area will be a radiological survey. Sampling activities will be limited to surface soil sampling. One monitoring well will be installed downgradient of the unit and sampled.

5.3.2 IHSS 142.1-9, 12 - Detention Ponds - A-Series and B-Series

There will not be any screening activities at the four A-series or five B-series ponds. Surface water and sediment samples will be collected in several locations in each pond. Sediment samples will also be collected from Walnut Creek upgradient and downgradient of the ponds and between the ponds. Background surface water and sediment samples will be collected north and west of the Plant. A total of four monitoring wells will be installed below detention ponds A-4 and B-5 and sampled.

5.3.3 IHSS 143 - Old Outfall

The screening activity that will be conducted at the Old Outfall site will be a radiological survey. Sampling will include surface soil sample collection and collection of soil samples to a depth of two feet below the original surface below the fill. In addition, soil samples will be collected upslope from the Old Outfall where the surface runoff was channeled to this area.

5.3.4 IHSS 156.2 - Soil Dump Area

Based on the finding of the aerial photograph and radiation survey results, surface and subsurface soil samples will be collected. One well will be installed within the unit and sampled.

5.3.5 IHSS 165 - Triangle Area

A radiological survey and a soil gas survey will be the screening activities conducted at the Triangle Area. Surface soil samples will be collected from plume areas delineated during the screening. Subsurface samples will be collected from the same locations as the surface samples. Two alluvial ground water monitoring wells will be installed within the IHSS and sampled.

5.3.6 IHSS 166.1-3 - Trenches A, B and C

The screening activity will consist of an electromagnetic geophysical survey which will be used to delineate the locations and extent of the trenches. Subsurface samples will be collected from borings drilled along the long axis of the trenches. One groundwater well will be installed east of IHSS 166.2 and sampled.

5.3.7 IHSS 167.1-3 - North, South and Pond Area Spray Fields

There will not be any screening activities conducted at the Spray Fields. Based on the findings of the aerial photograph review, surface and subsurface soil samples will be collected in each spray field area using a grid location system. Two alluvial ground water monitoring wells will be installed and sampled, one downgradient of the North Area Spray Field and one downgradient of the South Area Spray Field.

5.3.8 IHSS 216.1 - East Area Spray Field

Although the IAG does not specify field sampling at this site, limited surface and subsurface soil samples will be collected within this unit.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG, as a minimum, as described in subsection 7.3. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific QA requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Subsection 7.3 of this work plan specifies analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPjP and the Data Validation Functional Guidelines (EG&G 1990a). These documents state that the results of data review and validation activities will be documented in data validation reports.

5.5 TASK 5 - DATA EVALUATION

Data collected during the Phase I Walnut Creek drainage RI will be incorporated into the existing database and used to better define site characteristics, source characteristics, the nature and extent of contamination, to evaluate proposed remedial alternatives, and to support the baseline risk assessment and environmental evaluation.

5.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross-sections. Geologic data will be used to further characterize the stratigraphy of the alluvium and colluvium at each site and to better define the depth to bedrock and the bedrock type. Geologic data from boreholes will provide information on the size and depths of the trenches and Old Outfall.

Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigraphic characteristics of units present
- Aquifer hydraulic parameters
- Hydraulic gradients
- Water table depth and configuration

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize Walnut Creek and the A- and B-series ponds.

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU6 and integrate consistently with sitewide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU6, a regional scale surface water flow and transport model will be developed. This model will include the Walnut Creek segments that exist on Rocky Flats Plant. The model will be integrated with pond models to simulate the Walnut Creek system. The regional model may be expanded to include off-site segments as necessary. Where required, IHSS-specific flow and transport models will be developed and integrated to the regional scale model.

5.5.2 Source Characterization

The data collected during the Phase I RFI/RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the IHSSs and off-site sources located topographically and/or hydraulically upgradient or upwind of the sites. Analytical data from soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

5.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants in these media. Results of sampling will be compared with results of the ongoing background geochemical characterization to assess if chemical concentrations are above background levels. Products of these analyses may include isopleth maps, cross-sections and profiles, chemical tables, and statistical results.

5.6 TASK 6 - PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU6 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether remedial actions are necessary.

The risk assessment process will be accomplished in five general steps:

- Identification of chemicals of concern
- Exposure assessment
- Toxicity assessment
- Qualitative and quantitative uncertainty analysis
- Risk characterization

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Baseline Risk Assessment Plan for OU6, Section 8.0 of this work plan. The Environmental Evaluation work plan is presented in Section 9.0 of this work plan.

5.7 TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

Remedial Alternatives Development/Screening

This section identifies potential technologies applicable to the remediation of contaminated soils, wastes, and groundwater at OU6. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies, assembling an initial screening of alternatives and identification of potential interim remedial actions will be conducted while the RFI/RI investigation is being conducted. However, the investigation of this operable unit is in its early stages and thus remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives of each IHSS will be performed as more data are collected. It is important to recognize that additional phases of investigation may be required at some IHSSs prior to final screening of alternatives.

The process that will be employed to develop and evaluate alternatives for Operable Unit Number 6 is similar to the EPA Superfund process for selecting remedial alternatives. The Superfund Comprehensive Environmental Recovery, Compensation and Liability Act of 1980 (CERCLA) process is described in detail in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA 1988a). The CERCLA process was adopted because it specifies in the greatest detail the steps that should be followed for selection of remedial alternatives. In addition, the IAG requires general compliance with both Resource Conservation and Recovery Act (RCRA) and CERCLA guidance.

The steps followed to develop remediation alternatives for the IHSSs in OU6 are:

- Develop site remedial action objectives based on: chemical- and radionuclide-specific standards (when available); site-specific, risk-related factors; and other criteria, as appropriate.

- Develop preliminary risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives (along with chemical-specific Applicable or Relevant and Appropriate Requirements [ARARs]) for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. Consistent with the National Contingency Plan (NCP), preliminary remediation goals will be established at a 1×10^{-6} excess cancer risk point of departure and at other intervals within the 1×10^{-4} to 1×10^{-6} decision range. As the Feasibility Study evolves, preliminary remediation goals may be revised to a different risk level based on consideration of appropriate factors including, but not limited to: exposure, uncertainty, and technical issues.

- Develop a list of general types of actions appropriate for the IHSS areas constituting OU6 (such as containment, treatment, and/or removal) that may be taken to satisfy the objectives defined in the previous step. These general types or classes of action are generally referred to as "general response actions" in EPA guidance.

- Identify and screen technology groups for each general response action. For example, the general response action for containment can be further defined to include the in situ stabilization of contaminants in a form that is less mobile or immobile in the environment. Other containment alternatives could consist of groundwater barriers, such as slurry walls. Screening will eliminate those groups that are not technically feasible at the site.

- Identify and evaluate process options for each technology group to select a representative process for each group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group. For example, a soil bentonite slurry wall may be selected as representative of vertical barriers and would be used for technical and cost comparisons.

- Assemble the selected representative technologies into potential interim response actions for each IHSS, if appropriate.

- Assemble the selected representative technologies into site closure and corrective action alternatives for the IHSS areas comprising OU6 that represent a range of treatment and containment combinations, as appropriate.

- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo a thorough and extensive analysis, alternatives will be evaluated in less detail than subsequent evaluations.

"Effectiveness" is an evaluation of the protectiveness of human health and the environment achieved by a remedial alternative action during construction and implementation and after the response objectives have been met. Evaluation of effectiveness in the short term is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term evaluation of effectiveness addresses the risk remaining to human health and the environment and is based on the permanent destruction of, the decreased mobility of, or the reduction in volume of toxic compounds achieved after response objectives have been met.

"Implementability" is a measure of both the technical and administrative feasibility of constructing and operating and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to site-specific conditions. "Technical feasibility" refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. "Administrative feasibility" refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for Rocky Flats and similar sites, with modifications made for Rocky Flats Plant conditions. Absolute cost accuracy is not necessary, but cost estimates should have the same relative accuracy for comparison and screening. The cost estimating procedures used during screening are similar to those that will be used during the later, detailed alternatives analysis. The later, detailed analysis, however, will receive more in-depth and detailed cost estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment unit operation at the site. Present-worth cost analysis will be used for alternatives to make the costs for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than 10 alternatives will be retained for detailed analysis (including containment and no-action alternatives). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. Also, it will be necessary to identify and verify the action-specific ARARs that each respective alternative will be required to meet.

For the Phase I RFI/RI work plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU6. Table 5-1 provides a list and description of general response actions and typical technologies associated with remediating soils, groundwater, sediments, and surface water. Table 5-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSSs comprising OU6. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 5-1 must be applied to the potential exposure pathways that will be identified for OU6. The response actions can be capable of providing control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that provide control over all pathways.

TABLE 5-1

GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
No Action	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and use restrictions	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security; fencing; deed use restrictions; warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restriction would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping; groundwater containment barriers; soil stabilization; enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Groundwater pumping; leachate collection; liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable to removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

TABLE 5-1
GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION
(Concluded)

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed.	Solidification; biological, chemical, and physical treatment.	Applied to removed source material; could be used to control all pathways. Applied to removed transport media, could control air, surface water, groundwater, and sediment pathways.
In Situ Treatment	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification; bioremediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways.
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfill; repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, could be used to control corresponding pathway (except air).
Monitoring	Short- and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where the contact could occur with the released contaminant.

The existing data regarding the site hydrogeologic characteristics and potential soil and groundwater contamination are not sufficient for implementing the screening process. The IAG and this work plan indicate that the following information will be collected during the Phase I RFI/RI for the characterization of the source and groundwater contaminants and for the preliminary screening of alternatives:

- Describe contaminant fate and transport
    - Collect and analyze soil and groundwater samples below and hydraulically downgradient of potential release areas to evaluate contaminant spread
    - Collect groundwater samples at selected locations to evaluate contaminant distribution
    - Collect and analyze surface water and sediment samples at the Detention Ponds
    - Collect sediment/surface soil samples in the creek/stream and beds
    - Collect surface soil samples at the North, Pond, and South Area Spray Fields, East Area Spray Field, Sludge Dispersal Area, Triangle Area, and Soil Dump Area
    - Describe and characterize hydrogeology beneath all IHSS areas

- Site physical characterization
    - Groundwater flow regime within the unconfined aquifer
    - Soil types and general engineering properties
    - Surface water flow regime
    - Depth to groundwater and saturated thickness of aquifers of concern

These data will provide for a thorough comparative evaluation of the technologies with respect to implementability, effectiveness, and cost, and will allow for informed decisions to be made with respect to the selection of preferred technologies. The FSP (Section 7.0) describes the methodology that will be followed to obtain the required information.

<u>Detailed Analysis of Remedial Alternatives</u>

It is unlikely that sufficient data will be generated during the Phase I investigation to allow a detailed analyses of remedial alternatives. The detailed analysis of each alternative will be performed when sufficient data is generated during the remedial selection process. The detailed analysis is not a decision-making process, but it is the process of analyzing and comparing relevant information in order to select a remedial action. Each alternative will be assessed against nine evaluation criteria, and the assessments will be compared to identify the key tradeoffs among the alternatives. Assessment against the nine evaluation criteria is necessary for the Feasibility Study (FS) and the subsequent Record of Decision (ROD)/Corrective Action Decision (CAD) to comply with the CERCLA/RCRA ARARs. The nine specific evaluation criteria are:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

These criteria are described in the CERCLA EPA guidance document (U.S. EPA 1988a). The initial two criteria are considered threshold criteria because these alternatives must be satisfied before further consideration of the remaining criteria. The next five criteria are considered the primary criteria on which the analysis is based. The final two criteria, state and community acceptance, are addressed during the final decision-making process after completion of the Corrective Measure/Feasibility Study Study (CMS/FS).

5.8 TASK 8 - TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or appropriate to support the OU6 RFI/RI.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis, and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives (Section 5.7) and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU6 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

- Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

- Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench- scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process and the regeneration process can be performed at either off-site or on-site facilities.

- Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

- Air Stripping - Air stripping is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

- Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

- Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

- Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbants are addressed separately, elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

  Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater (Rubel 1980). More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site (Barney et al. 1989). In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream-specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

- Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

  Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent (Sorg 1988). A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as 1 μg/l (Jelinek 1988). Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste. Although published information in the removal of plutonium from natural waters by ion exchange has not been found, there is indication that ionized plutonium is removable using this technology (Marston 1990).

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

- In Situ Biological Treatment - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

- Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

- Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

- Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganic, metal, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

- Physical Separation - Soil contaminants are often found to be associated with particular size fractions of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be effective means of reducing the volume of the material that requires further treatment. The processes used for soil fractionation include screening, classification, flotation, and gravity concentration.

- Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organic, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

5.9 TASK 9 - REMEDIAL INVESTIGATION REPORT

An RFI/RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail of the field activities that serve as the basis for the RFI/RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.

- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.

- Present site characterization results from all RFI/RI activities at OU6 to characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.

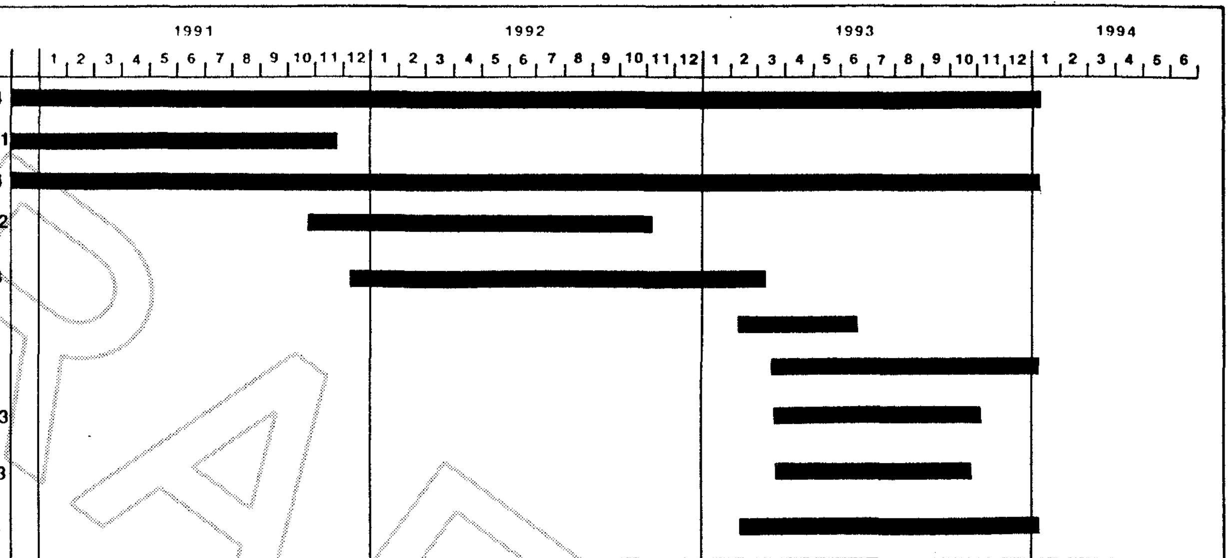
- Discuss contaminant fate and transport. This discussion will include potential contaminant migration routes, contaminant persistence, chemical attenuation processes and potential receptors.

- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.

- Present a summary of the findings and conclusions.

- Identify data needs for later phases of this investigation.

ACTIVITY	DATES START	DATES FINISH
PROJECT MANAGEMENT	18 Sep,90	7 Jan,94
TASK 1 - PROJECT PLANNING	18 Sep,90	20 Nov,91
TASK 2 - COMMUNITY RELATIONS	18 Sep,90	7 Jan,94
TASK 3 - FIELD INVESTIGATION	16 Oct,91	17 Nov,92
TASK 4 - SAMPLE ANALYSIS & DATA VALIDATION	2 Dec,91	8 Mar,93
TASK 5 - DATA EVALUATION	9 Feb,93	4 Jun,93
TASK 6 - BASELINE RISK ASSESSMENT	2 Mar,93	7 Jan,94
TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES	2 Mar.93	28 Oct,93
TASK 8 - TREATABILITY STUDIES	2 Mar,93	22 Oct,93
TASK 9 - PHASE I REMEDIAL INVESTIGATION REPORT	9 Feb,93	7 Jan,94



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PHASE I RFI/RI SCHEDULE

FIGURE 6-1 APRIL 1991

7.1 BACKGROUND AND SAMPLING RATIONALE

7.1.1 Background

The objectives of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) are:

- To characterize the physical and hydrogeologic setting of the Individual Hazardous Substance Sites (IHSSs)
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified in Section 4.0. The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will address the data needs and data quality objectives. The FSP developed in this section is based on the requirements of the IAG Statement of Work for Operable Unit 6 (OU6), and the data needs developed in Section 4.0. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to feasibility studies.

Generally, only limited information is available concerning the IHSSs in OU6 since there have been few previous investigations. Available information includes aerial photographs, site histories, and some analytical data for samples collected near the IHSSs. Little or no information exists specific to the physical characteristics of the sites, except for some of the A- and B-series ponds, or the nature and extent of the contamination, if present.

One of the objectives of the RFI/RI is to assess the presence or absence of contamination in the groundwater, surface water, and soils at the sites. A stepped approach as outlined in the IAG will be used in Phase I to achieve this objective. This approach requires an iterative process involving continuing reassessment of the site condition as the data are obtained. Based on this process, the subsequent field sampling program may be modified to collect more representative data for each IHSS. This FSP describes this stepped process.

7.1.3 Modifications to the IAG Plan

Several sampling and analytical activities described in the IAG have been modified in this FSP. These modifications, listed below, have been made so that each IHSS can be better evaluated during the Phase I investigation. Modifications to the Phase I sampling program are presented first followed by the modification to the Phase I analytical program.

<u>Sampling Program Modifications</u>

1) Both the Triangle Area (IHSS 165) and the Old Outfall (IHSS 143) appear to have been modified since waste disposal activities ceased at these locations. Fill has been added (origin of the fill unknown) and buildings have been constructed on the Old Outfall after waste disposal activities were discontinued. As much as 8 to 10 feet of fill may exist over the original surface. In addition, about 6 inches of surface fill has also been placed over parts of the Triangle Area. The Field Sampling Plan has been modified so that the surface soil sampling specified in the IAG can be taken from the original surfaces of these units. This will entail using borings to drill down to the original land surface so that samples can be collected at and below this surface. Composite samples of the fill will also be collected to determine if any contamination is present. The modifications to this sampling program are described in subsections 7.2.3 and 7.2.5.

2) Two-foot composite samples will not be used for volatile or semivolatile organics analysis at the Triangle Area (IHSS 165) or Trenches (IHSSs 166). Instead, discrete samples will be collected at two-foot increments for analysis. Composite samples are not appropriate for analysis of organic compounds, since a significant portion of the volatiles present in a sample can be volatilized during compositing of a sample.

3) The soil gas survey at the Triangle Area (IHSS 165) will be conducted on a 100-foot offset grid instead of the 50-foot grid specified in the IAG. If hot spots are detected, the size of the grid will be reduced in that area to locate the organics source.

4) One of the wells proposed in the Triangle Area (IHSS 165) will be drilled 20 feet into bedrock. The well within the PSZ will be screened in the first sandstone zone in the bedrock, if encountered. If there is not a sandstone zone in the boring, the well will be completed in the saturated alluvium. The purpose of the bedrock well is to confirm bedrock geology in this area and identify contamination, if present.

5) One well will be installed to monitor the saturated alluvium downgradient (east-southeast) of IHSS 166.2 (Trench B). It is suspected, based on the local topography, that Trench B may be near a groundwater drainage divide. Groundwater flow to the north from the trenches is

monitored by several wells while no monitoring wells exist to the east. The purpose of this additional well will be to provide data on possible groundwater contamination adjacent to this trench and in the eastward flow direction.

6) Five sediment samples are to be collected in each A-series and B-series pond as proposed in the IAG. However, three of the five locations have been changed so that more representative samples of the pond sediment can be obtained. The five locations proposed in this Phase I FSP are:

- In the deepest portion of the pond,
- In the pond, five feet from the inlet, and
- At three randomly selected locations within the pond.

The samples to be collected at the three random locations are the locations which have been changed from those specified in the IAG. These random samples will provide pond sediment data that can be statistically averaged, while the sediment samples collected from the deepest part of the ponds are likely to provide worst case concentrations. These average and worst case concentrations can then be used to better characterize the extent and nature of any contamination in the ponds and provide more useful data for the Phase I baseline risk assessment. The three original sampling locations specified in the IAG would provide non-random data that cannot be used in statistical analyses.

7) Surface and subsurface samples will be collected in the North, Pond and South Area Spray Fields (IHSSs 167.1, 167.2 and 167.3) on 100-foot grids. Since homogeneous liquids were sprayed across the spray fields, the 100 foot grid should adequately characterize the nature and extent of contamination, if present. In addition, two sediment samples will be collected in the drainage immediately east of the North Spray Field, to characterize potential downstream contamination.

8) Surface and subsurface soil samples will be collected on a 200-foot grid from the East Area Spray Field (IHSS 216.1). The purpose of these additional samples is to evaluate the presence or absence of contamination in that area. The rationale for this sampling is that if contamination is not found, then this IHSS may be removed from further phases of the RFI/RI process.

9) Four Phase I background sediment and surface water samples will be collected in the drainage area west of Walnut Creek and the existing landfill. Two of the samples will be collected along Walnut Creek west of the Plant security area and one from Walnut Creek immediately east of Highway 93. One sample will be collected west of Highway 93. The water samples will be collected quarterly for one year. These data, along with other site background data, will be

used to: (1) characterize the surface water quality upgradient of the IHSSs so that contaminant concentrations measured adjacent to the IHSSs can be evaluated to determine if they are characteristic of upgradient (background) conditions or represent contamination from an IHSS or other source; and (2) establish preliminary baseline water quality data for Walnut Creek.

10) IHSS 156.2, the Soil Dump Area, has been moved from Operable Unit No. 14 into OU6. The field sampling plan for this unit will consist of surface and subsurface samples taken on a 150-foot grid and one well installed in the first sandstone in the bedrock, if encountered within the boring drilled 20 feet into bedrock.

11) Two additional sediment samples will be collected in South Walnut Creek between the PSZ fence and Building 991 to characterize potential contamination upgradient of South Walnut Creek.

12) Five bedrock wells proposed for the Site-wide Geological Characterization Program will be installed in the vicinity of North Walnut Creek during the OU6 investigation. The purpose of these wells is to characterize the bedrock in the vicinity of the A-series ponds.

<u>Analytical Program Modifications</u>

1) Soil samples from the preexisting surface (below the fill) of the Triangle Area (IHSSs 165) will be analyzed for metals as well as for radioactive elements. This should provide more specific data on the potential for metals contamination at this site. Metal analyses have been added to this site because the wastes that were placed in this area may have contained metals, and for consistency, since the groundwater monitoring program calls for analysis of metals in wells near this IHSS.

2) A gamma radiation scan will be conducted by EG&G or its contractor on each of the sediment samples collected from the location at the deepest portion of the A and B series ponds. Sediment samples at these locations will be collected from the sediment core at five-centimeter intervals. The rationale behind this analysis is to evaluate whether contamination may exist in thinly stratified layers and to provide additional data to characterize pond sediment.

3) The IAG specifies that water and sediment samples be analyzed for soluble and insoluble radionuclides and metals. For the purposes of this Phase I investigation, each of the water samples will be filtered, with both the filtered and unfiltered aliquots analyzed for the specified metals and radionuclides. The filtered samples will provide data on the dissolved constituents and the unfiltered samples will provide data on the total constituent concentrations. Also, water

samples (both filtered and unfiltered) and sediments will be analyzed for both plutonium isotopes (239/240). This is consistent with the existing Rocky Flats analytical methods.

4) Several analyses have been added to the Phase I analytical program to assess chemicals of interest in the Environmental Evaluation. Groundwater from wells at the Triangle Area (IHSS 165), Trenches A, B and C (IHSS 166) and the North and South Area Spray Fields (IHSSs 167.1 and 167.3) and one-half of the sediment samples collected in Walnut Creek will be analyzed for TCL pesticides/PCBs. All surface (0-2 inches) soil samples taken in OU6 and sediment samples collected in Walnut Creek and the Ponds will be analyzed for total organic carbon (TOC).

7.2 INVESTIGATION PROGRAM

This section describes the Phase I investigation program for the IHSSs within OU6. For each IHSS, the tasks listed are generally divided into office activities prior to field sampling (Step 1), field screening activities prior to sampling (Step 2), field sampling activities (Step 3), and groundwater monitoring well installation and sampling (Step 4). As part of the field sampling program, data from the site-wide monitoring program will be used as appropriate to add to, or substitute for, the data collected during the Phase I investigation. The sites in OU6 are IHSS 141 - Sludge Dispersal Area, IHSS 142.1-9, 12 - A and B Series Detention Ponds, IHSS 143 - Old Outfall, IHSS 156.2 - Soil Dump Area, IHSS 165 - Triangle Area, IHSS 166 - Trenches A, B and C, IHSS 167 - North, Pond, and South Area Spray Fields, and IHSS 216.1 - East Spray Fields - North Area. For reference, the Phase I investigation programs for each IHSS are summarized below. A number of standard operating procedures (SOPs) will be used during the investigation. The SOPs are cited in this section and discussed further in Section 11.0 of this Phase I work plan.

7.2.1 IHSS 141 - Sludge Dispersal Area

Step 1 - Radiation Survey

A radiation survey will be performed over the areas affected by IHSS 141 (see Table 7-1). The radiation readings will be taken on a 25 ft. grid according to the procedure described in SOP 1.16 (Field Radiological Measurements). If hotspots are detected, the size of the grid will be reduced in that area to locate the radiation source. The results will be plotted and contoured on a map. The Phase I survey will be conducted using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake-type detector.

TABLE 7-1

PHASE I INVESTIGATION
IHSS 141 - SLUDGE DISPERSAL AREA

Activity	Purpose	Location	Number of Samples or Locations
Radiation survey	Locate radiation hotspots	Entire site - 25 ft grid	NA
Surface soil sampling	Characterize surface contamination and radiation hotspots	Entire site - 25 ft grid and hotspots except under buildings and roads	60
Install well	Monitor alluvial groundwater downgradient of the unit	See Figure 7-1	1

NA - Not Applicable

Step 2 - Surface Soil Sampling

Surface soil samples will be collected to a depth of 2 in. on a 25 ft. grid over IHSS 141 (Figure 7-1) according to the procedures in SOP 3.8, Surface Soil Sampling. Surface soil samples will also be collected from hotspots located during the radiation survey. Grid points located in paved areas (road) or under buildings within this IHSS will not be collected. A discussion of the analytical program for these samples is contained in subsection 7.3.

Step 3 - Monitoring Well

One monitoring well will be installed downgradient of IHSS 141 (Figure 7-1). The location of the well will be selected after completion of the Step 2 activities and after a review of the geologic conditions at the site. The proposed well location will be submitted to EPA and CDH for review and approval prior to its installation. This well will be screened to monitor the saturated alluvium. It will be drilled according to SOP 3.2, installed according to SOP 3.6, and developed according to SOP 2.2. Following development, the well will be sampled according to SOPs 2.5 and 2.6. The Phase I analytical program for samples collected from this well is contained in Section 7.3. The results of the first round of sampling will be reported in the Phase I Report. The well will be sampled quarterly for one year.

7.2.2 IHSS 142.1-9, 12 - A and B Series Detention Ponds

Step 1 - Review Existing Data

Surface water and sediment samples are currently being collected at locations in the Walnut Creek drainage as part of ongoing monitoring activities at the Rocky Flats Plant. The sampling locations, methodology, analytical parameters, and results from this monitoring will be reviewed prior to Phase I activities to assess potential overlap between programs. Data collected during these ongoing monitoring activities may satisfy the requirements of this OU6 program and will be utilized, if appropriate (Table 7-2). Also, as specified in the IAG, the 1986 Rockwell International report entitled "Trends in the Rocky Flats Surface Water Monitoring" (U.S. DOE 1986a) and other data pertaining to these ponds will be submitted to the EPA and CDH.

Step 2 - Surface Water and Sediment Samples

Five surface water samples will be collected from each of the four A-Series Detention Ponds and the five B-Series Detention Ponds and IHSS 142.12. At least one of the five water samples from each pond will be taken from the deepest part of the pond. As specified in the IAG, stratification of the water column at this location will be identified through temperature and/or dissolved oxygen measurements taken according to SOP 4.8. If stratification of the pond is identified, grab water samples will be taken

TABLE 7-2

PHASE I INVESTIGATION
IHSS 142.1-9 and 142.12 - A and B SERIES PONDS

Activity	Purpose	Location	Number of Samples or Locations
Collect surface water samples	Characterize surface water contamination	5 locations in each pond and from each vertically stratified zone at the deepest point in the pond	72
Collect sediment samples in ponds	Characterize sediments in ponds and contamination	5 locations in each pond. Samples will also be taken from each 5 centimeter interval of sediment from the deepest part of each pond.	50
Collect sediment samples in other locations on Walnut Creek	Characterize Walnut Creek sediments and contamination	See Figure 7-4 and text.	32
Collect background sediment and surface water samples upgradient of Walnut Creek	Characterize background levels upgradient of Walnut Creek	Four locations west of the Plant and Walnut Creek.	4 surface water and 4 sediments
Install wells	Monitor alluvial groundwater downgradient of the Ponds A-4 and B-5	Below ponds A-4 and B-5 dams (2 each)	4

from each vertically stratified zone. The second water sample from each pond will be collected from within 5 feet of the inlet of the pond. The third water samples from each pond will be taken within 5 feet of the pond spillway. The other two sampling locations will be randomly selected based on the size of the pond at the time of sampling. The surface water sample collected at each location will consist of a composite sample from the entire vertical water column, except for the grab samples at the deepest sampling location (described above). Samples will be collected according to SOPs 4.1, 4.2 and 4.8 as they apply to pond water sampling.

Five sediment samples will be collected from each of four A-Series Detention Ponds the five B-Series Detention Ponds and IHSS 142.12 (Figures 7-2 and 7-3). One of the five sediment samples will be collected from within 5 feet of the pond inlet. The second sediment sample will be taken from the deepest parts of each pond. The other three samples will be taken at random locations within the area of the pond as it exists at the time of sampling. All sediment samples will represent the entire vertical column of sediment present at each location. If sediment depth is greater than 2 feet, 2-foot composite samples will be collected. Sediment samples will be geologically logged according to SOP 3.1.

In addition to the above samples, grab sediment samples will be collected from discrete vertical intervals in the sediment core taken from the deepest part of the pond. These sediment samples will consist of composite samples collected at 5-centimeter intervals in this core. Each of these samples will be analyzed by a gamma radiation scan.

Sediment samples will also be collected along Walnut Creek from adjacent to Building 118 to Indiana Street (Figure 7-4). These stream sediment samples will be collected within the stream at points that are conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than two feet then two-foot composite samples will be collected. The following tabulation provides the number of samples that will be collected from several sections of Walnut Creek. The sediment samples from each of these stream segments will be collected at approximately evenly spaced intervals.

Interval	Number of Sediment Samples
North Walnut Creek Between Pond A1 and Building 118	7
South Walnut Creek Between Pond B-1 and the PSZ	4
One Sediment Sample between each of the Detention Ponds	7
Between Pond A-4 and Confluence of South and North Walnut Creek	4
Between Pond B-5 and Confluence of South and North Walnut Creek	4
Between Confluence of South and North Walnut Creek and Indiana Street	4
South Walnut Creek between the PSZ and Building 991	2

The approximate locations for the above sediment samples are shown in Figure 7-4. All sediment samples listed above will be collected according to SOP 4.6 and the SOP Addendum (SOPA) to SOP 4.6 in Section 11.0 of this document. The chemical analyses that will be performed on these samples are presented in Subsection 7.3. Only one-half of the sediment samples will be analyzed for pesticides/PCBs.

In addition to the sampling within OU6, four sediment and surface water samples will be collected west of OU6 to provide background information on Walnut Creek. Two sediment and surface water samples will be collected along Walnut Creek west of the Plant security area. One sediment and surface water sample will be collected from Walnut Creek immediately east of Highway 93 near its crossing of the South Boulder Diversion Canal. One sediment and surface water sample will be collected west of Highway 93. The samples will be collected according to SOPs 4.1, 4.2, 4.3 and 4.6. The background water samples will be collected quarterly for one year.

Step 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of each dam at Pond A-4 and at Pond B-5 for a total of 4 wells (Figure 7-2 and Figure 7-3). The wells will be constructed within the original stream channel according to SOP 3.6 and will monitor the saturated alluvium. Following development of the wells according to SOP 2.2, the wells will be sampled according to SOPs 2.5 and 2.6. Results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for one year. The analytical program for samples from these wells is discussed in subsection 7.3.

Five bedrock monitoring wells will be installed in the North Walnut Creek area to further characterize the bedrock and to determine if the Arapahoe No. 4 sand is present in this area. These wells are planned for installation during the Site-wide Geologic Characterization program; however, if the OU6 investigation precedes the Site-wide program, then the wells will be installed as part of the OU6 field program. The five wells will be installed in the approximate locations shown on Figure 7-4 to depths ranging from 80 to 120 feet, according to SOP 3.6 and will monitor the Arapahoe No. 4 sandstone, if present. Following development of the wells according to SOP 2.2, the wells will be sampled as part of the Site-wide monitoring program with results reported in that program.

7.2.3 IHSS 143 - Old Outfall

Step 1 - Radiation Survey

A radiation survey will be performed over the area affected by IHSS 143 according to SOP 1.16. The radiation readings will be taken on a 10-foot grid (Table 7-3). If hotspots are detected, the size of the

TABLE 7-3

PHASE I INVESTIGATION
IHSS 143 - OLD OUTFALL AREA

Activity	Purpose	Location	Number of Samples or Locations
Radiation survey	Locate radiation hotspots	Entire site - 10 ft grid	NA
Surface soil sampling	Characterize surface contamination and radiation hotspots	Entire site - 20 ft grid and hotspots, and along drainage	11
Subsurface soil sampling	Characterize top two feet of soil and radiation hotspots	Same as surface locations. Sampling will extend to 2 feet below the fill layer	11
Fill sampling	Determine if contamination is present to fill	Composite sample of fill from every fourth soil boring	3

NA - Not Applicable

grid will be reduced in that area to pinpoint the radiation source. The results will be plotted and contoured on a map. The survey will be conducted using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake-type detector.

Step 2 - Surface and Subsurface Soil Sampling

Surface soil samples will be collected to a depth of 2 inches below the existing ground surface at the central location of all areas identified by the radiation survey as having above-background radiation levels. These samples will be collected according to SOP 3.8.

The Old Outfall is an area where fill has been placed since waste discharge activities ceased at this site. Fill thicknesses may vary from 0 to 10 feet. Since the area of interest is the pre-fill ground surface, it will be necessary to drill through the fill to collect samples from the original ground surface. Soil borings in IHSS 143 will be drilled on a 20-foot grid, except under buildings, to a depth of 2 feet below the original pre-fill surface (see Figure 7-5). One sample will be collected from the top of the prefill surface to 2 inches below the pre-fill surface. The second sample will be collected from 2 inches to 24 inches below the prefill surface. Composite samples will be collected from the entire vertical section of the fill section in every fourth boring. The borings will be drilled according to SOP 3.2. In addition to the above borings, one boring will be drilled just east of the east culvert and sampled similar to the above borings (see Figure 7-5).

7.2.4 IHSS 156.2 - Soil Dump Area

Step 1 - Review Aerial Photographs and Previous Radiation Surveys

Aerial photographs will be evaluated to identify the extent of the Soil Dump Area (Table 7-4). Previous radiation surveys of the area, including the plant-wide flyover survey, will be reviewed to identify if any radiation hot spots are present.

Step 2 - Surface Soil Samples and Soil Borings

Surface soil samples will be collected to a depth of 2 inches on a 150-foot grid over the Soil Dump Area (Figure 7-1). Surface soil samples will be collected according to SOP 3.8. Soil borings will be drilled 3-feet into the undisturbed soil beneath the soil piles on the same 150-foot grid according to SOP 3.2. Samples will be taken continuously in these borings and will be composited from each 2-foot interval. These samples will be analyzed for radioactive elements (see subsection 7.3).

TABLE 7-4

PHASE I INVESTIGATION
IHSS 156.2 - SOIL DUMP AREA

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs and radiation surveys	Identify extent	Entire site	NA
Surface soil samples	Characterize surface materials and contamination and radiation hotspots	Entire site - 150-ft grid	12
Soil borings	Characterize subsurface conditions and materials	Entire site - 150-ft grid. Borings will be drilled 3 ft into the undisturbed soils beneath the soil piles	12
Install wells	Monitor groundwater in bedrock sand zone, if encountered	In western part of unit	1

NA - Not Applicable

During sampling a soil classification survey will be completed in the Soil Dump Area for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Step 3 - Monitoring Well

One monitoring well will be installed in this IHSS to monitor groundwater underlying the Soil Dump Area. The well will be located in the western part of the unit (Figure 7-1). The well will be drilled 20 feet into bedrock. If a sandstone zone is present in the boring, then the well will be completed to monitor the sandstone layers. The purpose of this well is to confirm bedrock geology and to characterize the presence of contamination in this area, if present. The well will be drilled according to SOP 3.2, installed according to SOP 3.6 and developed and tested according to SOP 2.2. During slug testing of this well, special attention will be directed towards characterizing this stratigraphic sandstone lenses in the bedrock, if present. Following development, the well will be sampled according to SOPs 2.5 and 2.6 The proposed analytical program for samples from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. This well will be sampled quarterly for one year.

7.2.5 IHSS 165 - Triangle Area

Step 1 - Review Aerial Photographs

Aerial photographs from 1953, 1964, 1969 and 1971 will be re-evaluated to identify the extent of the disposal area (Table 7-5). The aerial photographs suggest that the site extends farther to the north, east and west than is presently mapped. Additional studies conducted on or near the Triangle Area after preparation of this work plan will also be evaluated. These include investigations currently planned for Operable Unit 2 and the investigation planned for IHSS 176 (S & W Contractor Storage Yard), which partially overlaps this area. Also during Step 1 any reports or documents concerning the radiometric surveys conducted from 1975 to 1983 and any cleanup activities at this site will be submitted to the EPA and CDH.

Step 2 - Radiation and Soil Gas Surveys

A radiation survey will be performed over the Triangle Area on a 25-foot grid, excluding the PSZ fence area, (Figure 7-1) according to the procedures specified in SOP 1.16. If hotspots are detected, the size of the grid will be reduced in that area to locate the radiation source. The results will be plotted on a map and contoured. The survey will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector.

TABLE 7-5

PHASE I INVESTIGATON
IHSS 165 - TRIANGLE AREA

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify extent	Entire site	NA
Radiation survey	Locate radiation hotspots	Entire site - excluding PSZ fence - 25 ft grid	NA
Soil gas survey	Locate plumes of volatiles	Entire site - excluding PSZ fence - 100 ft grid	56
Soil classification survey	For Environmental Evaluation	Entire site	NA
Surface soil samples	Verify presence or non-presence of volatiles identified during soil gas survey and characterize radiation hotspots	VOC and radiation hotspots	6-15
Soil cores	Verify presence or non-presence of volatiles identified during soil gas survey	Random basis, 1 sample, every 25 soil gas samples, at the depth of the soil gas probe.	3
Soil borings (if plumes are identified)	Transect plumes identified by soil gas or radiation survey, if identified	Three borings transecting three highest soil gas locations. Borings will be drilled 3 ft. into weathered bedrock.	Maximum of 9
Install wells	Monitor groundwater under the unit	One well east of PSZ and one in north part of unit within PSZ	2

NA - Not Applicable

A real-time soil gas survey will be conducted over the Triangle Area, excluding the PSZ fence area (Figure 7-1) to evaluate the presence of organic volatile compounds. Soil gas samples will be taken on a 100-foot offset grid according to the procedures described in SOP 3.9. If organics are detected, the size of the grid will be reduced in that area to locate the organics source. The probe will be driven two to four feet into the soil, below the fill, if possible, to collect the sample. The soil gas samples will be analyzed for carbon tetrachloride, trichloroethene (TCE), dichloromethane, acetone, 2-butanone, tetrachloroethene (PCE), 1,2-dichloroethane (DCA), chloroform and toluene. Analytical peaks of compounds for which the gas chromatograph (GC) is not calibrated will be noted. The soil gas survey will be conducted using a portable GC. The analytical program for this soil gas survey is further discussed in Subsection 7.3.2.

Step 3 - Soil Cores, Surface Soil Samples and Soil Borings

Soil cores will be collected on a random basis to confirm the results of this survey. One soil core will be collected for every 25 soil gas samples at the same depth as the soil gas samples. In addition, surface soil samples will be collected at the locations of volatile organic or radiation plumes, if detected. The surface soil samples will be taken at the surface of the fill material and at the original ground surface according to the procedures described in SOP 3.8.

During sampling, a soil classification survey will be completed at the Triangle Area for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

If plumes are identified by the soil gas survey, soil borings will be utilized to transect the plumes. At each plume area one soil boring will be placed at the location of the highest soil gas reading and two borings will be drilled downgradient of that point. Three borings will be placed at up to three areas where plumes have been identified by the soil gas survey at the Triangle Area, resulting in a maximum of 9 borings for this area. The soil borings will be drilled 3 feet into weathered bedrock according to the procedures described in SOP 3.2. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot increment and analyzed for organic compounds as described in subsection 7.3. Samples will be composited from every 6-foot interval and analyzed for radionuclides as described in subsection 7.3.

Step 4 - Monitoring Wells

Two monitoring wells will be installed within this IHSS to monitor the groundwater in the Triangle Area. Two locations have been tentatively selected on the north side of the triangle area where there are currently no wells present (Figure 7-1). One of these wells will be located east of the PSZ fence, and the other well will be located within the PSZ. Final locations for the Phase I wells will be selected following a review of the existing well locations at the time of the investigation. The wells will be drilled according to SOP 3.2 and installed according to SOP 3.6. The well west of the PSZ fence will be drilled 20 feet into bedrock. If a sandstone zone is present in this boring, then the well will be completed in the sandstone. If the sand is not present, the well will be completed in the saturated alluvium. The well east of the PSZ fence will be completed in the saturated alluvium. The wells will be developed according to SOP 2.2. Following development, the wells will be sampled according to SOPs 2.5 and 2.6. The proposed analytical program for samples from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. These wells will be sampled quarterly for one year.

7.2.6 IHSS 166 - Trenches A, B and C

Step 1 - Review Aerial Photographs

Aerial photographs from 1964 and 1969 will be re-evaluated to identify the extent of the trenches (Table 7-6). The dimensions and locations of the trenches will be measured from the aerial photographs and used for preliminary locations for the geophysical surveys.

Step 2 - Geophysical Survey

Surface geophysical techniques will be utilized to estimate the location and lateral extent of Trenches A, B, C. Electromagnetics (EM) methods will be employed. Electrical conductivity variations are expected between the undisturbed soils and rock and those areas disturbed by trenching and sludge deposits. EM methods provide a rapid means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Analysis of conductivity variations should allow the trenches to be mapped.

The EM method involves induction of electrical current into the earth. A time-varying magnetic field is generated by a transmitter coil inducting a current into the ground. This primary field induces a secondary field that is measured by a receiver coil. Changes in magnitude and phase of the individual currents are converted to voltages and output in ground conductivity values. These values are then analyzed for variations across the site.

The EM survey will be conducted over the suspected trench locations. Sufficient data will be collected to obtain "background level" conductivities. General EM line locations are shown in Figure 7-6. Approximately 4,500 feet of EM data will be collected utilizing a 10-foot station spacing. This spacing will allow good resolution of trench lateral extent.

TABLE 7-6

PHASE I INVESTIGATION
IHSS 166 - TRENCHES A, B, AND C

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify location and extent of the trenches	Entire site	NA
Geophysical survey	Locate and delineate extent of the trenches	Each trench area	NA
Soil classification survey	For Environmental Evaluation	Entire site	NA
Soil borings	Characterize materials and contamination in trenches and size of trench	Transecting the trenches longitudinally every 25 ft. Borings will be drilled to 5 ft below the bottom of the trench.	26
Install well	Monitor alluvial groundwater downgradient of Trench B (166.2)	In most eastward boring at IHSS 166.2, immediately east of the trench	1

NA - Not Applicable

A geonics EM-31 ground conductivity meter will be used for the EM data collection. Data will be collected in the horizontal dipole mode, which provides depth penetration to nine feet, and the vertical dipole mode, which provides depth penetration to 18 feet. Given the shallow depth of the Arapahoe/Laramie Formation in this area (8-15 feet), these penetration depths will be sufficient. However, preliminary analysis will allow a determination if increased penetration is required. If so, a geonics EM-34 will also be used allowing penetration depths of 25-30 feet.

After completion of the survey, conductivity values will be plotted and contoured over each grid area. A non-disturbed area and the trench locations will be evaluated in this interpretation. If the E-M method is unsuccessful, ground penetrating radar (GPR) will be used to aid trench detection and delineation, GPR is an electromagnetic sounding technique, and operates on the principle that electromagnetic waves emitted from a transmitter antenna are reflected from buried objects and detected at a receiver antenna. Reflections are observed for subsurface materials that have different dielectric permittivities than the host material. Subsurface metal, refuse, or trench edges often possess substantial dielectric permittivity contrasts allowing these subsurface features to be mapped. Under favorable conditions, subsurface features can be detected to 20 or 30 feet.

In practice, the success of a GPR survey is highly site dependent. The depth of GPR penetration is a function of the near-surface soil conductivity. In areas where clay or conductive soil is near the surface, penetration can be reduced to a couple of feet or less. For this reason, a test line will be conducted at each survey site to ensure penetration is sufficient to detect subsurface trenches. The test line will also test various antennas for an optimum choice, as well as determine data recording parameters.

Upon confirmation that the method is producing sufficient penetration, a series of profiles will be conducted at each survey site over suspected trench areas. A Subsurface Interface Radar (SIR)-3 or SIR-8 system will be used to collect the radar data. Profile radar results will be correlated to all other data, both geophysical and geological, to interpret trench locations.

Step 3 - Soil Borings

As specified in the IAG, soil borings will be drilled on 25-foot centers along the long axis of each of the trenches (Figure 7-6). The borings will be drilled and sampled according to SOP 3.2 and will be terminated 5 feet below the bottom of each trench. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot interval and analyzed for TCL volatiles. Samples will be composited from every 6-foot interval and analyzed for TAL metals, and radioactive elements (see Subsection 7.3). Since it is possible that groundwater may be encountered in these borings, the borings should be completed during the period of low water table in the fall to limit the potential of encountering groundwater in the borings.

During sampling a soil classification survey will be completed at the Trenches for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Step 4 - Monitoring Well

One monitoring well will be installed to monitor the saturated alluvium downgradient of trench B (Figure 7-6). This well will be installed in the most eastward boring at trench B, immediately east of the trench, according to the procedures described in SOP 3.6. If the alluvium is dry, and the bedrock consists of sandstone, then this well will be installed in the saturated portion of the sandstone. The well will be developed according to SOP 2.2 and sampled according to SOPs 2.5 and 2.6 following development. Results of the first round of sampling will be reported in the Phase I RI Report. This well will be sampled quarterly for one year.

7.2.7 IHSS 167 - North, Pond, and South Area Spray Fields

Step 1 - Review Aerial Photographs

Aerial photographs from 1988 will be reviewed to evaluate the location and extent of the north, south, and pond area spray fields (Table 7-7). The sampling program proposed in Step 2 may be modified if the sizes of these IHSSs are modified.

Step 2 - Surface Soil Samples, Soil Borings, and Sediment Sampling

Surface soil samples will be collected to a depth of 2 inches on a 100-foot grid over the areas of the spray fields as estimated from the air photo review conducted in Step 1 (Figure 7-6). Surface soil samples will be collected according to SOP 3.8. Soil borings will be drilled to a depth of 4 feet on the same 100-foot grid according to SOP 3.2. Samples will be taken continuously and will be composited from each 2-foot interval. The analytical program for these samples is described in subsection 7.3.

During sampling a soil classification survey will be completed at the Spray Fields for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Two stream sediment samples will be collected in the drainage east of the North Area Spray Field (IHSS 167.1). These samples will be collected within the stream at points that are conducive to the collection of sediment (Figure 7-4). The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. The samples will be collected according to SOP 4.6 and the SOPA to SOP 4.6.

TABLE 7-7

PHASE I INVESTIGATION
IHSS 167 - NORTH, POND, AND SOUTH AREA SPRAY FIELDS

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify location and extent of the units	Entire site	NA
Soil classification survey	For Environmental Evaluation	Entire site	NA
Surface soil sampling	Characterize surface contamination	Entire site - 100 ft grid	57
Soil borings	Characterize subsurface conditions and contamination to 4 ft.	Entire site - 100 ft grid	57
Collect sediment samples	Characterize sediments and contamination downstream of the unit	Within the drainage downstream of the unit	2
Install wells	Monitor alluvial ground water downgradient of the spray fields	Within the drainages downgradient of units 167.1 and 167.3	2

NA - Not Applicable

Step 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of the North Area and South Area spray fields to monitor the saturated alluvium (Figure 7-6). These wells will be located within the surface drainages that flow toward North Walnut Creek. The wells will be drilled according to SOP 3.2 and installed according to SOP 3.6 with the screen located in the alluvium just above the weathered bedrock. The wells will be developed according to SOP 2.2 and sampled according to SOPs 2.5 and 2.6 following development. The results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for one year.

7.2.8 IHSS 216.1 - East Area Spray Field

Step 1 - Historical Data

As specified in the IAG, historical information regarding the use of the East Spray Field (IHSS 216.1) will be obtained and submitted to the EPA and CDH. The review of this IHSS that was performed for this work plan indicated that this spray field only operated during 1989 and received water from Pond B-3 (see Section 2.0). Analyses of the Pond B-3 surface water from 1989 indicates that fairly low concentrations of radionuclides, metals, and organics were present.

Step 2 - Surface Soil Samples and Soil Borings

Surface soil samples will be collected to a depth of 2 inches on a 200-foot grid over the entire site (Table 7-8 and Figure 7-3). Samples will be collected according to SOP 3.8. In addition soil borings will be located on the same 200-foot grid as the surface soil samples. The borings will be drilled to a depth of 4 feet according to SOP 3.8. Samples will be taken continuously and will be composited from each 2-foot interval. The analytical program for these soil samples is described below.

7.3 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected during the Phase I investigation. This section discusses sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation.

7.3.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the Rocky Flats Environmental Database System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings,

TABLE 7-8

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER SAMPLES

Parameter	Container	Preservative	Holding Time
Liquid - Low to Medium Concentration Samples			
Organic Compounds:			
Purgeable Organics (VOCs)	2 x 40-mℓ VOA vials with teflon-lined septum lids	Cool, 4°C[a] with HCl to pH<2	7 days 14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 4-ℓ amber[b] glass bottle	Cool, 4°C[a]	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2; Cool, 4°C	180 days[c]
Cyanide	1 x 1-ℓ polyethylene bottle	Sodium hydroxide[d] pH>12; Cool, 4°C	14 days
Anions	1 x 1-ℓ polyethylene bottles	Cool, 4°C	14 days
Sulfide	1 x 1-ℓ polyethylene bottle	1 mℓ-zinc acetate sodium hydroxide to pH>9; Cool, 4°C	7 days
Nitrate	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Total Dissolved Solids (TDS)	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Radionuclides	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2;	180 days

[a] Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine

[b] Container requirement is for any or all of the parameters given.

[c] Holding time for mercury is 28 days.

[d] Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each liter of sample volume.

"SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "WC" for Woodward-Clyde). One sample number will be required for each sample generated, including QA/QC samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the database. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU6. Boring numbers will be developed independently of the sample number for a given boring. Specific sample location numbers are not assigned at this time, pending the results of the aerial photograph analysis and review of existing data.

7.3.2 Analytical Requirements

Generally, samples from the Phase I RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Nitrate
- Target Analyte List (TAL) metals
- Uranium 233/234, 235 and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta
- Tritium
- Total Dissolved Chromium (water only)
- Total organic carbon (TOC)
- TCL volatile organics
- TCL semivolatile organics
- TCL pesticides/PCBs
- CO_3, HCO_3, Cl, SO_4, NO_3 (water only)

The specific analytes in the groups listed above and their detection/quantitation limits are contained in Table 7-9. The specific Phase I analytical programs for each IHSS are contained in Table 7-10. Both filtered and unfiltered samples, surface water and groundwater samples will be analyzed at each location.

The analytical program for each media at every IHSS is summarized in Table 7-10. This analytical program for each IHSS was developed in the IAG based on the type of waste suspected to be present at each site. The specific analytes and detection/quantitation limit are specified in the IAG by reference to CLP (Contract Laboratory Program) analyses. The General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1990d) provides a listing of CLP analytes and limits that will be used for this Phase I RFI/RI. These analytes and limits are presented in Table 7-9. The program shown in Table 7-10 should address the bulk of chemicals and compounds that were handled or suspected

TABLE 7-9

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

	DETECTION LIMITS*	
TARGET ANALYTE LIST - METALS	Water (µg/l)	Soil/Sediment (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Lithium	100	20
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Molybdenum	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium	200	40
Thallium	10	2.0
Tin	200	40
Vanadium	50	10.0
Zinc	20	4.0
TOTAL ORGANIC CARBON	1	1
	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES	Water (µg/l)	Soil/Sediment (µg/kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5

TABLE 7-9
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES (Continued)	Water (µg/l)	Soil/Sediment (µg/kg)
total 1,2-Dichloroethene	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
trans-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
cis-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		

	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - SEMIVOLATILES	Water (µg/l)	Soil/Sediment (µg/kg)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-di-n-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 7-9
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	QUANTITATION LIMITS* Water (µg/l)	Soil/Sediment (µg/kg)
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330

TABLE 7-9
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water (µg/l)	Soil/Sediment (µg/kg)
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

TARGET COMPOUND LIST - PESTICIDES/PCBS	QUANTITATION LIMITS*	
	Water µg/l	Soil/Sediment µg/kg
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDD	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5	80.0
gamma-Chlordane	0.5	80.0
Toxaphene	1.0	160.0
Aroclor-1016	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

TABLE 7-9
(Concluded)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	REQUIRED DETECTION LIMITS*	
RADIONUCLIDES	Water (pCi/ℓ)	Soil/Sediment (pCi/g)
Gross Alpha	2	4 dry
Gross Beta	4	10 dry
Uranium 233+234, 235, and 238 (each species)	0.6	0.3 dry
Americium 241	0.01	0.02 dry
Plutonium 239+240	0.01	0.03 dry
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.1 dry
Strontium 89+90	1	1 dry

	DETECTION LIMITS*
Parameters Exclusively for Groundwater Samples	Water (mg/ℓ)
ANIONS	
Carbonate	10
Bicarbonate	10
Chloride	5
Sulfate	5
Nitrate as N	5
FIELD PARAMETERS	
pH	0.1 pH unit
Specific Conductance	1
Temperature	
Dissolved Oxygen	0.5
Barometric Pressure	
INDICATORS	
Total Dissolved Solids	5

* Detection and quantitation limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

TABLE 7-10
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	Total U	Total Cr	Be	H3	Nitrate	Gross α	Gross β	U 233/234	U 235	U 238	Pu 239/240	Am 241	Cs 137	Sr 89/90
141	Surface samples on 25' grid	Soil		X	X		X	X	X	X	X	X	X	X		
	Well downgradient of unit	Water	X					X	X							
142	Sediment samples	Seds.		X	X	X	X	X	X	X	X	X	X	X	X	X
	Water samples	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
	Water downgradient of A-4 and B-5	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
143	Surface and core samples on 20' grid	Soil		X	X	X	X	X	X	X	X	X	X	X		
156	Surface samples	Soil						X	X	X	X	X	X	X		
	Borings	Soil						X	X	X	X	X	X	X		
	Well within unit	Water						X	X	X	X	X	X	X		
165	Surface samples from transect locations	Soil	X		X			X	X	X	X	X	X	X		
	Borings to confirm soil gas	Soil														
	Borings transecting plumes grabs from 2' intervals 6' composites	Soil			X			X	X	X	X	X	X	X		
	Wells within the site	Water						X	X							
166	Borings along each trench grabs from 2' intervals 6' composites	Soil						X	X	X	X	X	X	X		
	Well downgradient of trench	Water						X	X							
167	Surface and core samples on 100' grid	Soil						X	X	X	X	X	X	X		
	Wells downgradient of units	Water				X	X						X	X		
216	Surface and core samples	Soil				X		X	X	X	X	X	X	X		

TABLE 7-10
PHASE I ANALYTICAL PROGRAM
(Concluded)

								Filtered						
IHSS	Location	Media	TAL Metals	TOC	TCL Vols	TCL Semi	TCL Pests	U	Pu 239/240	Cs 239/240	Sr 89/90	Am 241	TAL Met	Anions TDS
141	Surface samples on 25' grid	Soil	X											
	Well downgradient of unit	Water	X		X	X								
142	Sediment samples	Seds.	X	X	X	X	X							
	Water samples	Water	X		X	X		X	X	X	X	X	X	X
	Wells downgradient of A-4 and B-5	Water	X		X	X		X	X	X	X	X	X	X
143	Surface and core samples on 20' grid	Soil	X	X										
156	Surface samples	Soil		X										
	Borings	Soil												X
	Well within unit	Water	X					X	X			X	X	
165	Surface samples from transect locations	Soil		X										
	Borings to confirm soil gas	Soil			X	X								
	Borings transecting plumes	Soil												
	grabs from 2' intervals				X	X								
	6' composites		X											
	Wells within the site	Water	X		X	X	X							
166	Borings along each trench	Soil										X		
	grabs from 2' intervals				X									
	6' composites		X											
	Well downgradient of trench	Water	X		X	X	X							
167	Surface and core samples on 100' grid	Soil	X	X										
	Wells downgradient of units	Water	X		X		X	X	X					
216	Surface and core samples	Soil	X	X										

to be present at OU6 and enable detection of soil, sediment, surface water, and groundwater contamination, if present. Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present in Walnut Creek. Metals were handled at OU6; however, details are not well known. Therefore, all of the TAL metals plus other metals known to have been found on site have been selected for Phase I analysis.

Uranium is likely to have been a constituent of the wastes at OU6. The isotopes U-233, U-234, U-235 and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and is found at the Rocky Flats Plant. Therefore, plutonium and americium have been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium, strontium, and cesium are also included in the analytical program.

Volatile and semivolatile organics may have been handled at OU6 in small quantities. The specific compounds used are unknown; therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses. TCL pesticides/PCBs and TOC have been included to provide data for the environmental evaluation.

The analytical parameters for the soil gas survey at IHSS 165 are carbon tetrachloride, trichloroethene (TCE), dichloromethane, acetone, 2-butanone, tetrachloroethene (PCE), 1,2-dichloroethane (DCA), chloroform and toluene. Detection limits proposed for these parameters during the soil gas survey are listed in Table 7-11.

7.3.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments. The water matrices for analysis will include surface water and groundwater. Tables 7-12 and 7-13 list analytical parameters of interest in OU6 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

TABLE 7-11

PHASE I INVESTIGATION
SOIL GAS PARAMETERS AND
PROPOSED DETECTION LIMITS

IHSS-165 Triangle Area

Volatiles	Detection Limit
methylene cloride	1 μg/l
acetone	1 μg/l
2-butanone	1 μg/l
chloroform	1 μg/l
carbon tetrachloride	1 μg/l
toluene	1 μg/l
PCE	1 μg/l
TCE	1 μg/l
1,2 DCA	1 μg/l

NOTE: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

TABLE 7-12

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER SAMPLES

Parameter	Container	Preservative	Holding Time
Liquid - Low to Medium Concentration Samples			
Organic Compounds:			
Purgeable Organics (VOCs)	2 x 40-mL VOA vials with teflon lined septum lids	Cool, 4°C[a] with HCl to pH<2	7 days 14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 4-L amber[b] glass bottle	Cool, 4°C[a]	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1-L polyethylene bottle	Nitric acid pH<2; Cool, 4°C	180 days[c]
Cyanide	1 x 1-L polyethylene bottle	Sodium hydroxide[d] pH>12; Cool, 4°C	14 days
Anions	1 x 1-L polyethylene bottles	Cool, 4°C	14 days
Sulfide	1 x 1-L polyethylene bottle	1 mL-zinc acetate sodium hydroxide to pH>9; Cool, 4°C	7 days

[a] Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine

[b] Container requirement is for any or all of the parameters given.

[c] Holding time for mercury is 28 days.

[d] Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each L of sample volume.

TABLE 7-12

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER

(Concluded)

Parameter	Container	Preservative	Holding Time
<u>Liquid - Low to Medium Concentration Samples</u>			
Nitrate	1 x 1-L polyethylene bottle	Cool, 4°C	48 hours
Total Dissolved Solids (TDS)	1 x 1-L polyethylene bottle	Cool, 4°C	48 hours
Radionuclides (Full Suite)	12 x 1-L polyethylene bottle	Nitric acid pH<2	180 days

TABLE 7-13

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
<u>Soil or Sediment Samples - Low to Medium Concentration</u>			
Organic Compounds:			
Purgeable Organics (VOCs)	1 x 4-oz wide-mouth teflon lined glass vials	Cool, 4°C	14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 8-oz wide-mouth teflon lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8-oz wide-mouth glass jar	Cool, 4°C	180 days[1]
Cyanide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8-oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 1-L wide-mouth glass jar	None	45 days

[1]Holding time for mercury is 28 days.

7.3.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP 1.14.

7.3.5 Data Reporting Requirements

Field data will be input into the RFEDS environmental database using a remote data entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed QC process based on SOP 1.14 to be generated by EG&G.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate the timely reporting of the information. This data will also be delivered to EG&G on 3.5-inch diskettes. Computer hardware and software requirements for contractors using government supplied equipment will be supplied by EG&G. Computer and data security will also follow acceptable procedures outlined by EG&G.

7.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the ER Project Manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their applications are discussed below. The frequency for QC samples to be collected and analyzed is provided in Table 7-14.

Duplicate samples will be collected by the sampling team and will be used as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (subsection 7.3.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation technique. As indicated by Table 7-14, these QC samples are applicable only to samples requiring chemical preservation.

TABLE 7-14

FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics (Volatiles)	NR	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on nondedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample containers. Equipment rinsate blanks are applicable to all analyses for water and soil samples as indicated in Table 7-14.

Trip blanks consisting of deionized water will be prepared by the laboratory technician and will accompany each shipment of water samples for volatile organic analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of volatile organics or any problems associated with the shipment, handling, or storage of the samples.

Procedures for monitoring field QC are given in the site-wide Quality Assurance Project Plan (QAPjP).

8.1 OVERVIEW

A baseline health risk assessment will be prepared for Operable Unit Number 6 (OU6) as part of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) report. Both a human health evaluation and an environmental evaluation will be performed. This section describes the human health risk assessment. The environmental risk assessment is described in Section 9.0 of this work plan.

The purpose of the Phase I baseline risk assessment is to confirm the presence or absence of contamination at OU6 and provide an estimate of potential health risks that may result from releases of hazardous substances from OU6 in the absence of any remedial action. Risks will be calculated for both on-site and off-site exposures to chemicals released and/or transported from the Individual Hazardous Substance Sites (IHSSs) using available data as well as data collected during the Phase I investigation of the unit.

The purpose of the baseline risk assessment is to provide information useful in determining the following, as described in the National Contingency Plan:

- A determination of whether the contaminants of concern identified at the site pose a current or potential risk to human health in the absence of any remedial action
- A determination of whether remedial action is necessary at IHSSs within the unit, and an identification of the exposure pathways needing remediation
- A justification for performing remedial actions

This assessment will follow the guidance provided by the Environmental Protection Agency (EPA). It will also make use of additional information and methods that will facilitate interpretation of the results of the risk assessment. EPA publications that will be consulted when performing the health risk assessment include the following:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. 1989. EPA/540/1-89/002.
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. 1988.
- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001.

- Exposure Factors Handbook. 1989. EPA/600/8-89/043.
- Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008.

These documents constitute the most recent and appropriate EPA guidance on public health risk assessment. It must be emphasized that EPA manuals are guidelines only and that EPA states that considerable professional judgment must be used in their application. This risk assessment will focus on producing a realistic analysis of exposure and health risk.

The risk assessment will be accomplished in five general steps: identification of chemicals of concern, exposure assessment, toxicity assessment, uncertainty analysis, and risk characterization.

A separate risk assessment will be performed on each IHSS to the extent appropriate for the IHSS. Due to the separated locations, varied historical practices, and different contamination profiles, the IHSS should receive individualized treatment. This IHSS-specific analysis will allow the identification of the most important contributors to the risk from the operable unit, and it will permit sufficient attention to be paid to contaminants that may be important at one IHSS but not at another. IHSSs that do not contribute significant risks can then be identified so that efforts may be aimed at further analysis of the significant sources of risk.

8.2 IDENTIFICATION OF CHEMICALS OF CONCERN

Chemicals of concern are a subset of all the chemicals or other constituents, such as metals or radionuclides, that are identified at the unit. They are the chemicals that are evaluated in the baseline risk assessment. A two-step process will be used to identify chemicals of concern. First, an initial list of chemicals of potential concern are selected on the basis of the following criteria:

- They are identified in one or more samples at the IHSS.
- They are related to activities at the IHSS; they are potentially released from an identified source in the IHSS.
- They are recognized or suspected toxicants or carcinogens.
- They are present in significant concentrations (above background).

Chemicals of potential concern will be selected following evaluation of available historical and background sampling results and the results of the Phase I field sampling proposed for OU6. Existing background data will be used to help identify chemicals that are background constituents in the environment and that are therefore not IHSS-related. Background information is expected to be available from ongoing studies including the "Background Geochemical Characterization Report, Rocky Flats Plant." (EG&G 1990b).

Available historical data on chemical and radionuclide concentrations in groundwater, surface water, sediments, soils and air near OU6 will be used in conjunction with the results of the Phase I field sampling program to identify IHSS-related chemicals of concern.

Existing analytical results taken from other sources will be accepted as suitable for risk assessment purposes. The sampling and analytical program for the Phase I investigation of OU6 is described in Section 7.0 of this Work Plan. The sampling program is designed to adequately address all potential exposure pathways (groundwater, surface water, sediments, and soils) to the extent that they can be anticipated. Samples and analytical results obtained as part of the Phase I investigation will be collected and validated according to the Quality Assurance (QA)/Quality Control (QC) procedures described in that section. Only data validated as suitable for risk assessment purposes will be used in the risk assessment.

Tentatively Identified Compounds (TICs) will be evaluated to determine if they should be included in the risk assessment. If there are few of them in comparison to the Target Analyte List (TAL), they are normally omitted in accordance with EPA guidance.

The second step in the identification process will be followed if the number of chemicals of potential concern is high. In that case, the list may be further reduced to focus on the chemicals that pose the greatest risks at the site. Carrying a large number of chemicals through a quantitative risk assessment can be unwieldy, time-consuming, and may obscure the dominant risks at the site. The rationale for selecting a final list of chemicals of concern will be presented in the text and will be based on the following criteria:

- historical information
- concentration and toxicity
- mobility, persistence, and bioaccumulation
- special exposure routes
- treatability
- Applicable or Relevant and Appropriate Requirements (ARARs)
- chemical class
- frequency of detection (hits/sample)
- evaluation of essential nutrients
- concentration relative to background levels (natural or anthropogenic)
- potential for being a laboratory contaminant.

The results of data collection and evaluation and selection of chemicals of concern will be summarized in the text and appropriate tables.

8.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to identify human populations (receptors) that might be exposed to chemical releases from the IHSSs and to estimate the temporal variation and magnitude of their exposure. The exposure assessment involves identifying potential receptors, identifying all potential pathways of exposure, estimating exposure point concentrations of chemicals of concern based on monitoring data and modeling results, and estimating the intake of each chemical for each pathway. The results of the exposure assessment are pathway-specific chemical intakes, expressed as mg chemical/kg body weight/day, by potentially exposed receptor populations. Exposure to radioisotopes will be expressed as activity of intake for internal exposure or as activity in environmental media for external exposure.

Conceptual models of the IHSSs will be formulated and refined based on data collected to integrate the components of the exposure assessment and clarify the pathways to be considered.

8.3.1 Potential Receptors

The exposure scenarios that will be developed in the baseline risk assessment may include exposure of potential future receptors to contaminated media within the OU6 as well as exposure of off-site receptors to potentially contaminated groundwater, surface water, and airborne soil particulates. The exact exposure scenarios to be considered will be selected according to policy decisions regarding future use (e.g., residential, recreational, restricted access) of the site that may be made prior to the completion of the risk assessment.

8.3.2 Exposure Pathways

Identification of exposure pathways involves linking the source of chemical release, an environmental transport mechanism, a point of human exposure, and a mechanism of human uptake. Sources of chemical release will be sites within OU6 that contain chemicals of concern significantly above background levels. Mechanisms of release can include leaching of chemicals from soils into groundwater or surface runoff, airborne transport of contaminated soil particulates, volatilization of organic compounds, or release of radioactive particles. Points of human exposure will be identified during the site characterization. These may include sites within the operating unit as well as off-site locations where contaminants may be transported. Examples of mechanisms of human uptake are dermal contact with contaminated media, inhalation of volatile organics or particulates, and ingestion of soils or water.

Only complete exposure pathways will be evaluated in the risk assessment. If any one of the elements of an exposure pathway (chemical source and release, environmental transport mechanism, exposure point, or uptake) is missing, the exposure pathway is considered incomplete and will not be addressed in the assessment.

8.3.3 Exposure Point Concentrations

Exposure point concentrations of chemicals of concern will be estimated using analytical results of the sample program described elsewhere in this work plan and available relevant historical data. Release and transport of chemicals in environmental media may be modeled using basic analytical models recommended by EPA or the best model available, as determined by a model performance evaluation. The models will be calibrated to improve performance using site-specific parameters when possible.

Model outputs will be characterized by estimating variance through an uncertainty analysis to the extent required by the overall risk uncertainty analysis. Effort will be made to reduce the variance of model output: the optimal target for model variance is that it be similar to other sources of variability in the risk assessment, including exposure factors and toxicity values.

Concentrations will also be estimated for "average" and "reasonable maximum" exposure conditions at a minimum. When feasible, a goodness-of-fit analysis will be conducted to correctly identify the distribution of the data and the most appropriate measure of central tendency. The reasonable maximum concentration will be the upper 95 percent confidence limit on the appropriate mean or maximum likelihood estimate. In calculating the media concentrations, censored data (data sets with missing values, nondetects, etc.) will be treated by appropriate methods such as those described in Gilbert, 1987 (Statistical methods for environmental pollution monitoring, Van Nostrand Reinhold).

8.3.4 Estimation of Intake

Human intakes of chemicals of concern will be estimated using reasonable estimates of exposure parameters. EPA guidance, site-specific factors, and professional judgment will be applied in establishing exposure assumptions. Using reasonable values permits estimating risks associated with the assumed exposure conditions that do not underestimate actual risk. The estimate of intake is the "intake factor," which may then be mathematically combined with the exposure point concentrations and the critical toxicity values to determine cancer risks and hazard indices.

8.4 TOXICITY ASSESSMENT

The toxicity assessment is conducted to characterize the evidence regarding the potential for a chemical of concern to cause adverse effects in exposed populations and, where possible, to estimate the relationship between the extent of exposure and the extent of adverse effects (i.e., dose-response relationship). The toxicity assessment evaluates:

- The evidence for toxic effects of the chemical
- The nature of the dose-response relationship
- The level of uncertainty in the dose-response relationship
- The primary target organs or mechanism of action for each compound of concern
- The applicability of the toxicologic data to the identified exposure scenarios

Sources of toxicity factors (cancer slope factors and reference doses) used in assessing health risks due to exposure to organic compounds, metals, and radionuclides include EPA's Integrated Risk Information System (IRIS) and the most current volume of EPA's Health Effects Assessment Summary Tables. Other sources in the public domain, such as the National Research Council's reports on the Biological Effects of Ionizing Radiation, reports IV and V, and EPA's Background Information Document, Draft E/S for Proposed National Emission Standards for Hazardous Air Pollutants (NESHAPS) for Radionuclides, will be consulted as appropriate. New toxicity data and analyses of the health risks of contaminants of concern will be considered as they become available in the literature. No new experimental toxicological data will be developed.

The toxicity assessment will include a discussion of the uncertainties inherent in the development and application of toxicity factors. The text will include a discussion of the EPA weight-of-evidence classification for carcinogens, the conservatism inherent in applying upper 95th percentile cancer slope factors, the uncertainty factors used in deriving reference doses, and other uncertainties involved in predicting human responses.

In addition, those chemicals that present the greatest risk at the site will receive additional toxicological analysis to more fully describe the potential range of appropriate critical toxicity values based on such considerations as mechanism of carcinogenesis, the validity of toxicity endpoints used to derive the reference dose (RfD), or pharmakokinetic information that may provide insight on extrapolation from one species to another.

8.5 QUALITATIVE AND QUANTITATIVE UNCERTAINTY ANALYSIS

Presentation of uncertainties and limitations of the risk analysis is an integral part of the risk assessment process. Usually, uncertainty is discussed after the risk characterization has been completed. However, in this risk assessment, the uncertainty analysis will provide substantial input into the risk characterization process.

Uncertainties exist primarily in the estimation and modeling of exposure point concentrations, the estimation of human exposures, and the use of toxicology data based on animal studies. These uncertainties will be described qualitatively to provide an understanding of the issues. In addition, a detailed quantitative analysis of the uncertainty will be presented to the extent practicable.

Several methods are available for quantitative analysis. The uncertainty analyses will be performed to quantify, to the extent practicable, the sources and magnitude of uncertainty in the baseline risk assessment. Quantitative techniques may include: sensitivity analysis, first-order analysis, or numerical methods such as stratified Monte Carlo sampling. The outputs will be described and interpreted in the text. This will inform the risk manager of the sufficiency of the baseline risk assessment given the level of site characterization at the conclusion of Phase I, the degree of confidence that is appropriate for the risk estimates, and a basis for further remedial activities at the site.

8.6 RISK CHARACTERIZATION

Risk characterization integrates the toxicity factors for the chemicals of concern with the estimated chemical intakes and radiation exposures under the assumed exposure conditions to yield screening-level carcinogenic and noncarcinogenic health risks. The IHSS conceptual model will be consulted again at this point to determine realistic combinations of exposure pathways as well as maximum likelihood/reasonable maximum estimates for those pathways. Risks to receptors associated with different chemicals and exposure routes will be summed across exposure pathways that are likely to occur simultaneously in order to estimate total noncarcinogenic and carcinogenic risk from chemicals and radioisotopes. When toxicants with known mechanism of action or target organ specificity in humans can be identified, their hazards will be segregated and considered separately.

The results of the risk characterization, both average, reasonable maximum, and reasonable minimum exposure conditions as determined by the uncertainty analysis will be summarized in tables and discussed in the text. The risk characterization will therefore be an unbiased estimate of risks upon which risk management decisions may be based. Populations that may be affected by the real or potential risks will be identified to the extent that is possible. These results will be discussed in the context of the output from the uncertainty analysis described above. This information will allow the risk manager to make a more informed decision on a final deterministic cleanup value.

9.0
ENVIRONMENTAL EVALUATION PLAN

9.1 INTRODUCTION

The objective of this Environmental Evaluation Plan is to provide a framework for addressing risks to the environment from potential exposure to contaminants resulting from IHSSs within the Walnut Creek Drainage, OU6. This plan is prepared in conformance with the requirements of current applicable legislation, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and follows the guidance for such studies as provided in the National Contingency Plan (NCP) and Environmental Protection Agency (EPA) documents for the conduct of Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) activities. Specifically, the EPA guidance provided in Risk Assessment Guidance for Superfund, Vol. II, Environmental Evaluation Manual (U.S. EPA 1989e) is followed.

The goal of the environmental evaluation is to determine the nature and extent of potential impacts of contamination from OU6 to biota (plants, animals, and microorganisms). Determination of the effects on biota will be performed in conjunction with the human health risk assessment for OU6. Where appropriate, criteria necessary for performing the environmental evaluation will be developed in conjunction with human health risk assessments and environmental evaluations for all Rocky Flats Plant OUs. Information from the environmental evaluation will assist in determining the form, feasibility, and extent of remediation necessary for Walnut Creek Priority Drainage in accordance with CERCLA.

During preparation of this work plan, several documents were reviewed as part of an assessment of available information. These included the Final EIS, Rocky Flats Plant (U.S. DOE 1980); Wetlands Assessment (EG&G 1990h); and the Draft Environmental Evaluation Work Plan for OU2 (in RFI/RI Alluvial Work Plan, EG&G 1991b). Literature reviews will continue throughout the environmental evaluation. Review of this Draft Phase I RFI/RI Work Plan for OU6 and the Environmental Evaluation Work Plan for OU2 (EG&G 1991b) formed the basis for the establishment of the initial sampling locations discussed in the OU6 Field Sampling Plan (Subsection 9.3).

9.1.1 Approach

This plan presents a comprehensive approach to conducting the environmental evaluation at Walnut Creek Drainage. This comprehensive approach is designed to ensure that all procedures to be performed are appropriate, necessary and sufficient to adequately characterize the nature and extent of environmental effects to biota under the "no action" scenario. As is recommended by EPA, this environmental evaluation is not intended to be or to develop into a research-oriented project. The plan presented herein is designed to provide a focused investigation of potential contaminant effects on biota.

Each task of the environmental evaluation will be coordinated with RFI/RI activities at nearby operable units in order to avoid unnecessary duplication of effort and resources. Environmental evaluation planning is currently underway at OU2 (903 Pad, Mound, and East Trenches Area) which is in close proximity to OU6. A coordinated approach with this operable unit is necessary in order to account for contaminant migration into OU6.

The environmental evaluation process has been divided into ten tasks. These tasks and their interrelationships are shown on Figure 9-1. The following is a brief description of each of these tasks. More detailed descriptions of each task are presented in Subsection 9.2.

Task 1: Preliminary Planning

Task 1 will focus on planning and coordination of the OU6 environmental evaluation with OU6 RFI/RI and Human Risk Assessment activities and with other operable unit activities. Task 1 will include a determination of the scope of work and a definition of the study area. Data Quality Objectives (DQO) will be defined in Task 1 according to EPA guidance (U.S. EPA 1989d), and procedures for monitoring and controlling data quality will be specified. Task 1 activities will also include development of criteria for selection of contaminants of concern, key receptor species, and reference areas.

Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

Task 2 will include a review, evaluation, and summary of available chemical and ecological data and identification of data gaps. Based on these data, a preliminary ecological risk assessment will be performed to identify contaminants of concern and their documented effects on key receptor species and/or other ecological endpoints. As part of this preliminary risk assessment, a food web model will be developed and preliminary exposure pathways will be identified. Results of this task will be used to refine the ecological and ecotoxicological field investigation sampling designs.

Task 3: Ecological Field Investigation

Task 3 will include the preliminary field surveys and an ecological field inventory to characterize OU6 biota and their trophic relationships and to note locations of obvious zones of chemical contamination. Brief field surveys will be conducted in the spring, summer, fall, and winter to obtain information on the occurrence, distribution, variability, and general abundance of key plant and animal species. Field inventories will be conducted in late spring and summer to obtain quantitative data on community composition in terrestrial and aquatic habitats. Samples collected as part of the activity will be saved for tissue analyses where contaminants of concern have been identified and sampling protocol are in place. Task 3 will also include aquatic toxicity tests using *Ceriodaphnia spp.* and fathead minnows. As part of these activities, all collected field data will be reduced, evaluated, compared with and integrated into the existing data bank to update knowledge of site conditions.

Task 4: Toxicity Assessment

Task 4 will entail compilation of toxicity literature and the toxicological assessment of potential adverse effects from contaminants of concern on key receptor species. This task will be performed in conjunction with Task 5.

Task 5: Exposure Assessment and Pathways Model

Task 5 will entail development of a site-specific pathways model based on the ecological field investigation and inventory. This exposure-receptor pathways model will be used to evaluate the transport of contaminants at OU6 to biological receptors. The pathways model is based on a conceptual pathways approach (Fordham and Reagan 1991) and will provide an initial determination of the movement and distribution of contaminants, likely interactions among ecosystem components, and expected ecological effects. It is anticipated that this approach will be coordinated with the efforts of investigators working in other operable units to avoid duplication of effort, to collect comparable data, and to provide a consistent assessment of environmental risk.

Task 6: Preliminary Contamination Characterization

Task 6 will provide a characterization of the risk or threat of OU6 contaminants to receptor populations and habitats and a summary of risk-related data concerning the site. Determinations will be made as to the magnitude of the effects of contamination on OU6 biota. The actual or potential effects of contamination on ecological endpoints (e.g., species diversity, food web structure, productivity) will also be addressed. Depending on DQOs and the quality of data collected, the contamination characterization will be expressed qualitatively, quantitatively, or a combination of the two. Task 6 may include the preliminary derivation of remediation criteria. Development of these criteria will entail consideration of federal and Colorado laws and regulations pertaining to preservation and protection of natural resources that are Applicable or Relevant and Appropriate Requirements (ARARs) (see Section 3.0). Information from ARARs, toxicological assessments, and the pathways model will be used to develop criteria that address biological resource protection.

Task 7: Uncertainty Analysis

Task 7 includes the identification of assumptions and the evaluation of uncertainty in the environmental risk assessment analysis. Task 7 will include the identification of data needs to calibrate/validate the pathways model developed in Task 5.

Task 8: Planning

Task 8 will entail the development of additional DQOs with respect to the conduct of the Task 9, Ecotoxicological Field Investigation. DQOs to be achieved by such sampling will be defined according to EPA guidance (U.S. EPA 1989d). Scoping and design of the Task 9 field studies will be based initially on the outcome of the Task 2 preliminary risk assessment. Field sampling will only be performed where acceptance criteria for demonstrating injury to a biological resource will be satisfied in accordance with regulations under the Natural Resource Damage Assessment Rule [40 CFR Subtitle A Section 11.62 (f)].

Task 9: Ecotoxicological Field Investigation

Task 9 will include tissue analysis studies and any additional ecotoxicological field investigations. Samples collected in Task 3 field studies will be used wherever possible (e.g., when contaminants of concern have been identified and sampling protocols are in place); new samples will be collected if necessary. The need for measuring additional population endpoints through reproductive success, enzyme inhibition, or other ecotoxicological studies will be evaluated based on the Task 3 preliminary ecological risk assessment. Selection of target analytes, species, and tissues will be based on the determination of which contaminants are likely to be present in sufficient concentrations, quantities, and locations as to be detected in biota. All necessary federal and state permits will be obtained prior to any destructive sampling or collecting.

Task 10: Environmental Evaluation Report

Task 10 will provide a final characterization of contamination in biota at OU6. Results from the Task 9 ecotoxicological field investigations will be used to evaluate ecosystem effects. Information on site environmental characteristics and contaminants, characterization of effects, remediation criteria, conclusions, uncertainty analysis, and limitations of the assessment will be summarized into the Environmental Evaluation Report.

Each of the preceding tasks is described in further detail in Subsection 9.2. A suggested outline for the Environmental Evaluation Report is presented in Subsection 9.2.11. The field sampling plan presented in Subsection 9.3 addresses both the Task 3 ecological investigation and the Task 9 ecotoxicological field investigations. A tentative schedule for performing the environmental evaluation is presented in Subsection 9.4.

9.1.2 OU6 Contamination

A number of chemicals are suspected to be present in the soils and surface water at OU6 (see Table 9-1). Preliminary reviews of available data show some chemicals (organics, metals, and radionuclides) in surface water to be above detection levels (Tables 2-2 through 2-12). Which of these levels are above background is currently being evaluated as part of the RFI/RI effort. Most of the chemicals shown in Tables 2-2 through 2-12 and Table 9-1 are likely to impact biota if present at sufficient concentrations. The following subsections present a discussion of which of these chemicals are likely to be of paramount concern at OU6 given their toxic nature. Actual selection of contaminants of concern to biota will take place in Task 2 after a more detailed analysis of potential adverse effects and review of available toxicological literature.

9.1.2.1 Metals

Terrestrial Ecosystems

Data on contaminant levels in soils at OU6 are not yet available as this is a Phase I RFI/RI investigation. Based on the occurrence of metal contaminants in OU6 aquatic ecosystems, contamination of terrestrial ecosystems can be expected. Heavy metals are the most commonly evaluated environmental contaminants in biomonitoring studies of terrestrial ecosystems. Studies on heavy metals are of several types: (1) reports of metal concentrations in animals from only one location, (2) correlations of tissue concentrations with environmental concentrations, (3) monitoring a site through time, (4) concentrations in animals collected along a gradient of pollution, and (5) comparisons of concentrations in animals from reference and contaminated sites or sites where contamination is suspected. These studies generally provide information on background concentrations of contaminants and correlations of tissue concentrations with environmental concentrations. Data from the Talmage and Walton (1990) study is available for most heavy metals for a variety of mammal species and lower trophic levels.

Several of the heavy metals detected in aquatic ecosystems at OU6 are phytotoxic and are also known to bioaccumulate and biomagnify in terrestrial ecosystems. Bioaccumulation, the process by which chemicals are taken up by organisms directly or through consumption of food containing the chemicals, is documented for arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and selenium. Biomagnification, or the process by which tissue concentrations of chemicals increase as the chemical passes up through two or more trophic levels, is documented from soil to plants for beryllium, cadmium, chromium, copper, lead, mercury, and selenium. In herbivores, biomagnification occurs for antimony, arsenic, cadmium, chromium, copper, lead, mercury and selenium. In terrestrial carnivores, mercury

TABLE 9-1

CHEMICALS DETECTED AT OU6

A-SERIES PONDS (IHSS 142.1 through 142.4) and 142.12

Surface Water

Organics:	phenol, aldrin
Metals:	strontium, manganese, zinc, mercury, aluminum, nickel, cyanide, lead, lithium, cadmium, copper, beryllium, and tin
Radionuclides:	americium-241, cesium-137, plutonium-239, radium 226, strontium 90, tritium, uranium 233/234, uranium-235, and uranium-238

B-SERIES PONDS (IHSSs 142.5 through 142.9)

Surface Water:

Organics:	phenol
Metals:	manganese, mercury, selenium, strontium, zinc, lead, beryllium, cadmium, tin, silver, aluminum, and copper
Radionuclides:	americium-241, cesium-137, plutonium-239, radium-226, radium-228, strontium-90, tritium, uranium-233/234, uranium-235, and uranium-238
Anions:	nitrate/nitrite

Sediments:

Radionuclides:	plutonium-239, uranium, and strontium 90

NORTH AND SOUTH POND AREA SPRAY FIELD (IHSSs 167.1 through 167.3)

Surface Water:

Organics:	2-methylnaphthalene, 4-methylphenol, acenaphthene, bis (2-ethylhexyl) phthalate, napthalene, phenanthrene, phenol, 2,4-dimethylphenol, benzoic acid, benzyl alcohol, di-n-butyl phthalate, diethyl phthalate, and fluorene
Metals:	aluminum, lead, lithium, manganese, strontium, zinc, chromium, copper, mercury, barium, tin, and silver
Radionuclides:	americium-241, cesium-137, plutonium-239, strontium-90, tritium, uranium-233/234, uranium-235, uranium-238, and radium-226
Anions:	nitrate/nitrite

TABLE 9-1
(Concluded)

EAST AREA SPRAY FIELD (IHSSs 216.1)

Soil:

Organics: phenol

Metals: manganese, mercury, zinc, and aluminum

Radionuclides: americium-241, cesium-137, plutonium-239, strontium-90, tritium, uranium-233/234, uranium-235 and uranium-238

Anions: nitrate/nitrite and sulfates

SLUDGE DISPERSAL AREA (IHSS 141)

Soil:

Radionuclides: plutonium-239

TRIANGLE AREA (IHSSs 165)

Soil:

Metals: aluminum, arsenic, barium, beryllium, chromium, copper, lead, lithium, manganese, mercury, and molybdenum

Radionuclides: plutonium-239, radium-226, radium-228, uranium-233, 234, uranium-235, and uranium-238

Anions: nitrate/nitrite

OLD OUTFALL (IHSS 143)

Soil:

Radionuclides: unknown radioactive elements

Anions: nitrate and sulfate

SOIL DUMP AREA (IHSS 156.2)

Soil:

Radionuclides: plutonium-239

and cadmium are known to biomagnify. Depending on historical usage, concentrations detected in soils, and the biological receptors at OU6, any, if not all, of these metals are likely to become contaminants of concern in the OU6 environmental evaluation.

Aquatic Ecosystems

The EPA has established ambient water quality criteria (AWQC) to be protective of the environment (U.S. EPA 1986). Specifically, the criteria were established to be protective of all aquatic life forms. One rationale for establishing criteria protective of aquatic life is that aquatic organisms and plants are important in food chains to higher life forms. In addition, their direct dependence on the aquatic environment results in constant contact with the water and the organisms are therefore likely to assimilate any contaminants. One EPA objective in establishing AWQC was to determine chemical concentrations that would not be directly harmful to aquatic organisms and plants and would not present a hazard to higher life forms due to any biomagnification of individual chemical substances.

Of the metals detected in surface water at OU6, seven are of immediate interest in the evaluation of aquatic ecosystems given their presence at levels above Federal surface water quality standards (Table 9-2). These are aluminum, cadmium, lead, manganese, mercury, selenium, and zinc. Of the metals detected at elevated levels, cadmium, lead, mercury, selenium, and zinc are likely to be contaminants of concern because of their potential to biomagnify. Brief summaries of AWQC toxicity information (U.S. EPA 1986b, 1987c) on each of these latter metals are presented in the following text. Similar toxicity profiles will be evaluated against site-specific concentrations data in the selection of contaminants of concern and key receptor species. The occurrence of these metals at elevated levels in surface water does not necessarily imply that they are available for assimilation in all organisms or that they transfer to successive trophic levels. The potential for adverse effects to occur is dependent of a number of physiochemical factors including: (1) physiological and ecological characteristics of the organism; (2) forms of dissolved trace metals; (3) forms of trace metals in ingested solids; and (4) chemical and physical characteristics of water (Jenne and Luoma 1977). Each of these factors will be considered in the evaluation of potential adverse environmental effects at OU6.

Cadmium

Freshwater acute values for cadmium are available for species in 44 genera and range from 1.0 μg/l for rainbow trout to 28,000 μg/l for a mayfly. The antagonistic effect of hardness on acute toxicity has been demonstrated with five species. Chronic tests have been conducted on 12 freshwater fish species and 4 invertebrate species; chronic values range from 0.15 μg/l for *Daphnia magna* to 156 μg/l for the Atlantic salmon. Freshwater aquatic plants are affected by cadmium at concentrations ranging from 2 to 7,400 μg/l. These values are in the same range as the acute toxicity values for fish and invertebrate

TABLE 9-2

COMPARISON OF OU6 METALS CONCENTRATIONS TO FEDERAL SURFACE WATER STANDARDS

	ALUMINUM	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT
	SDWA MCL (Secondary) 50 to 200 μg/l[a]	SDWA MCL 50 μg/l	SDWA MCL 1000 μg/l	CWA AWQC (Acute) 130 μg/l (Chronic) 5.3 μg/l	CWA AWQC (Acute) 3.9 μg/l (Chronic) 1.1 μg/l	SDWA MCL 50 μg/l SDWA MCL 100 μg/l[a]	
OU6							
Pond A-1	N.D	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond A-2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond A-3	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond A-4	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond B-1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond B-2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond B-3	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond B-4	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pond B-5	N.D.	N.D.	N.D.	N.D.	18.8 μg/l	N.D.	N.D.
SW-96	2,180 μg/l	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SW-97	21,300 μg/l	N.D.	N.D.	N.D.	N.D.	21.5 μg/l	N.D.

TABLE 9-2
(Concluded)
COMPARISON OF OU6 METALS CONCENTRATIONS TO FEDERAL SURFACE WATER STANDARDS

	COPPER	LEAD	MANGANESE	MERCURY	NICKEL	SELENIUM	ZINC
	CWA AWQC (Acute) 18 µg/l (Chronic) 12 µg/l SDWA MCL (Secondary) 1000 µg/l	CWA AWQC (Acute) 82 µg/l (Chronic) 3.2 µg/l SDWA MCL 50 µg/l	SDWA MCL (Secondary) 50 µg/l	CWA AWQC (Acute) 2.4 µg/l (Chronic) 0.012 µg/l SDWA MCL 2 µg/l	CWA AWQC (Acute) 1,400 µg/l (Chronic) 160 µg/l	CWA AWQC (Acute) 260 µg/l (Chronic) 36 µg/l SDWA MCL 10 µg/l SDWA MCL 50 µg/l[a]	CWA AWQC (Acute) 120 µg/l (Chronic) 110 µg/l SDWA MCL 5000 µg/l
OU6							
Pond A-1	N.D.	N.D.	163 µg/l	N.A.	N.D.	N.D.	90 µg/l
Pond A-2	N.D.	N.D.	259 µg/l	0.2 µg/l	N.D.	N.D.	92.8 µg/l
Pond A-3	N.D.	N.D.	86 µg/l	0.5 µg/l	N.D.	N.D.	179 µg/l
Pond A-4	N.D.	N.D.	82 µg/l	0.6 µg/l	N.D.	N.D.	42 µg/l
Pond B-1	N.D.	410 µg/l	219 µg/l	0.7 µg/l	N.D.	28.3 µg/l	N.A.
Pond B-2	N.D.	450 µg/l	614 µg/l	0.4 µg/l	N.D.	N.D.	1,010 µg/l
Pond B-3	N.D.	232 µg/l	31.8 µg/l	0.8 µg/l	N.D.	N.D.	123 µg/l
Pond B-4	N.D.	470 µg/l	30.0 µg/l	6.6 µg/l	N.D.	N.D.	491 µg/l
Pond B-5	N.D.	608 µg/l	86.8 µg/l	1.0 µg/l	N.D.	8.5	310 µg/l
SW-96	N.D.	10.9 µg/l	29.7 µg/l	0.9 µg/l	N.D.	N.D.	29.3 µg/l
SW-97	N.D.	37.3 µg/l	2,110 µg/l	0.3 µg/l	N.D.	N.D.	6,050 µg/l

SDWA = Safe Drinking Water Act
MCL = Maximum Contaminant Level
AWQC = Ambient Water Quality Criteria

(a) EPA National Primary and Secondary Drinking Water Regulations, 40CFR Parts 141, 142, and 143, Final Rule effective July 30, 1992.

species, and are considerably above the chronic values. Bioconcentration factors (BCFs) for cadmium in fresh water range from 164 to 4,190 for invertebrates and from 3 to 2,213 for fishes.

Lead

The acute toxicity of lead to several species of freshwater animals has been shown to decrease as the hardness of water increases. At a hardness of 50 mg/L, the acute sensitivities range from 142.5 μg/l for an amphipod to 235,900 μg/l for a midge. Data on the chronic effects of lead on freshwater animals are available for two fish and two invertebrate species. The lowest and highest available chronic values (12.26 and 128.1 μg/l) are both for a cladoceran, but in soft and hard water respectively. Freshwater algae are affected by concentrations of lead above 500 μg/l, based on data for four species. BCFs are available for four invertebrate and two fish species and range from 42 to 1,700.

Several enzymes are sensitive to lead at very low concentrations. Lead strongly inhibits several ATPases, lipoamide dehydrogenase, and aminolevulinic acid dehydratase, which is involved in the synthesis of heme (Rand and Petrocelli 1985). In vertebrate animals, lead poisoning is characterized by neurological defects, kidney dysfunction, and anemia.

Mercury

Mercury is toxic to all forms of biota in aquatic ecosystems, although many factors (e.g., alkalinity, pH, and temperature) influence toxicity. The toxic action of mercury in plants and animals appears to involve cell membranes and their permeability. In mammals, early subacute poisoning generally has a neurological manifestation (Rand and Petrocelli 1985). Data are available on the acute toxicity of mercury(II) to 28 genera of freshwater animals. Acute values for invertebrate species range from 2.2 μg/l for *Daphnia pulex* to 2,000 μg/l for three insects. Acute values for fish range from 30 μg/l for the guppy to 1,000 μg/l for *Mozambique tilapia.* Few data are available for various organomercury compounds and mercurous nitrate, which are 4 to 31 times more acutely toxic than mercury(II).

Available chronic data indicate that methylmercury is the most chronically toxic of the tested mercury compounds. Tests on methylmercury with *Daphnia magna* and brook trout show chronic values less than 0.07 μg/l. For mercury(II), the chronic value for *Daphnia magna* is about 1.1 μg/l and the acute-chronic ratio is 4.5. In both a life-cycle test and an early life-stage test on mercuric chloride with the fathead minnow, the chronic value was less than 0.26 μg/l and the acute-chronic ratio was over 600.

Freshwater plants show a wide range of sensitivities to mercury, but the most sensitive plants appear to be less sensitive than the most sensitive freshwater animals to both mercury(II) and methylmercury. A BCF of 4,994 is available for mercury(II); BCFs for methylmercury range from 4,000 to 85,000.

Selenium

Although selenium can be quite toxic, it has been shown to be an essential trace nutrient for many aquatic and terrestrial species and it has been shown to ameliorate the effects of a variety of pollutants (e.g., arsenic, cadmium, copper, and mercury). Invertebrates have been shown to be both the most sensitive and the most resistant freshwater species to selenium(IV). Acute values for *Daphnia spp. range* from 6 μg/l to 3,870 μg/l for selenium(IV). Acute values in fish for selenium(IV) range from 620 μg/l for fathead minnow to 35,000 μg/l for carp. The final chronic value for selenium(IV) of 27 μg/l is based on sensitivities of rainbow trout. Based on data for three species, selenium(IV) was shown to be 5 to 32 times more toxic than selenium(VI). Although selenium(IV) appears to be more acutely and chronically toxic than selenium(VI) to most aquatic animals, this does not seem to be true for aquatic plants. Growth of several species of green algae were affected by concentrations ranging from 10 to 300 μg/l. BCFs that have been obtained for selenium (IV) with freshwater species range from 2 for the muscle of rainbow trout to 452 for the bluegill. Highest concentrations of selenium(IV) have been found in fish viscera, due to the uptake of selenium adhering to food.

Zinc

The levels of dietary zinc at which toxic effects are evident depend markedly on the concentration ratio of zinc to copper (Rand and Petrocelli 1985). Zinc is also a metabolic antagonist of cadmium, so that high zinc intakes in animals afford some protection against cadmium exposure. Acute toxicity values are available for 43 species of freshwater animals. Data indicate that acute toxicity generally decreases as hardness increases. When adjusted to a hardness of 50 mg/L, sensitivities range from 50.70 μg/l for *Ceriodaphnia reticulate* to 88,960 μg/l for a damselfly. Additional data indicate that toxicity increases as temperature increases. Chronic toxicity data are available for nine freshwater species. Chronic values for two invertebrates range from 46.73 μg/l for *Daphnia magna* to >5,243 μg/l for the caddisfly, *Clistoronia magnificia*. Chronic values for seven fish species range from 36.41 μg/l for flagfish, *Jordanella floridae*, to 854.7 μg/l for the brook trout, *Salvelinus fontinalis.* The sensitivity range of freshwater plants is greater than that for animals. Growth of the alga, *Selenastrum capriocornutum,* is inhibited by 30 μg/l; however, 4-day EC50s for several other species of green algae, exceed 200,000 μg/l. Zinc bioaccumulates in freshwater animal tissues at 51 to 1,130 times the water concentration.

9.1.2.2 Radionuclides

Basic ecological research on radionuclides in the environment has a 40-year history resulting in sophisticated models for identification and prediction of the movement and concentration of specific radionuclides. The same is true for effects resulting from exposure to both external and internal sources of radiation. Most of the scientific literature concerning radioecology has resulted from interaction between DOE operated facilities and nearby universities.

The following discussion is a brief summary of the radionuclide literature reviewed. In general, transuranics tend to bind in the soils and sediments and have limited availability to biota. Bioaccumulation or concentration factors routinely are low between trophic levels. Data from Little et al. (1980) from the Rocky Flats Plant site indicate that radionuclide inventories (and thus radiation doses) in vertebrate populations are well below levels know to elicit effects. Based on the following cursory literature review, it seems unlikely that, at the low dose levels reported, sufficient sensitive methods exist to distinguish adverse biological response due to radionuclides from background "noise" (chance fluctuations due to climate, weather, human disturbance, etc.) at the Rocky Flats Plant Site.

Terrestrial Ecosystems

Historically, the principal reason for determining BCFs for terrestrial biota was to calculate the internal radiation dose to higher trophic levels at an equilibrium body burden from radionuclides assimilated from foodstuffs. For the most part, BCFs for mammals have been collected from fallout studies under widely varied habitat conditions (arctic, desert, temperature zone, and laboratory) and, consequently, there are few consistent generalizations. Concentration factors for ^{137}cesium (Cs) typically show an increase from plant to mammalian herbivores as well as increases at the higher trophic levels. Ninefold increases in ^{137}Cs through the plant → mule deer → cougar food-chain were demonstrated in the work done by Pendleton et al. (1965). Also an increase of approximately 2 to 5 fold at each link in the lichen → caribou → wolf food-chain has been reported by Hanson et al. (1967).

Less comprehensive data are available for the other radionuclides, but it is evident that not all radionuclides are concentrated in food-chains and that different food-chains may exhibit markedly different concentration patterns for the same nuclide. Strontium-90 accumulation for the plant → herbivore chain ranges from 0.02 to 8.4; while the BCF's for tritium, ^{60}cobalt and ^{131}iodine are less than 1.0 with the exception of 2.4 for seed → water → quail for ^{60}Co movement (Auerbach 1973).

There have been few field studies on the comparative uptake of actinides (transuranics) by biota from contaminated soils. Uranium, thorium, and plutonium (Pu) transfer in terrestrial food-chains has not been well studied because of the difficulty and expense of analyzing these elements at low levels in biota and the frequent high degree of variation in field data that complicates statistical comparisons between different actinides. Field studies that have been conducted on soil-plant-animal transfer suggest that bioaccumulation of these elements does not occur. Hakonson (1975) indicates that at the Trinity Site, residual (Pu) levels in soils, plants, and animals were approximately 10 times lower in small rodents than in the corresponding grass samples. This same trend has been noted in other studies as well (Garten and Daklman 1978, Garten et al. 1981). Bly and Whicker (1978) found that the mean ratio of ^{239}Pu in arthropods to ^{239}Pu in 0 to 3 cm soil at Rocky Flats Plant was $9x10^{-3}$.

Little, Whicker, and Winsor (1980) conducted a comprehensive study in the grassland ecosystem around Rocky Flats. The overall conclusions mirror the previously mentioned works in that plutonium was not accumulated up through the food-chain. Additionally, the body burdens of biota were significantly lower than required to elicit a biological or ecological effect.

Most studies of radiosensitivities of soil fungal populations have been performed in the laboratory. Studies on the effects of irradiation of natural populations in the field have been rare and have suffered from inadequate controls (Stotsky and Mortenson 1959, and Stanovick, Giddens, and McCreery 1961)

A study by Edwards (1969), revealed distinct differences in radiosensitivities of various microarthropod groups, but all were killed at levels much lower than those lethal to microflora. Orbatid mites, the most radiation-resistant microarthropods, were killed by 200 kilorads. Auerbach et al. (1957) found that with lower radiation doses, a lag effect exists in growth rates in certain microarthropods, such as *Collembola*. Cawse (1969) noted that bacteria are the most tolerant to radiation up to about 2.5 megarads. Fungi are resistant up to about 1 megarad (Johnson and Osborne 1964).

Fraley and Whicker (1973) found native shortgrass plains vegetation to be very resistant to chronic gamma radiation at exposure rates varying from 0.01 to 650 rads/hr. One of the most resistant species was *Lepidium densiflorum* which became dominant at exposure rates of 12 to 28 rads/hr and was able to germinate, develop, and complete seed set at exposure rates greater than 28 rads/hr. The level of radiation exposure in their study is many orders of magnitude greater than any encountered in the environment around facilities such as Rocky Flats. The authors also reported that while community changes were apparent, the parameters used (coefficient of community and diversity) lacked the sensitivity to measure such change.

A long-term project was initiated in 1968 at Oak Ridge National Laboratory (Styron et al. 1975) to assess effects of mixed beta and gamma radiation from simulated fallout on a grassland ecosystem. Extensive statistical analyses of data on numbers of individuals collected for each of 76 arthropod and 2 molluscan taxa have identified no lasting significant changes in similarity or species diversity of experimental versus control communities as the result of the long-term irradiation at low doses rates. Natural fluctuations in community dynamics obscured any possible radiation effects.

Mammal species and populations exhibit a similar resistance to chronic low-level exposures and even acute exposures required in excess of 100 rads to elicit reproductive, hemopoietic, or survivorships responses (Kitchings 1978).

Aquatic Ecosystems

Aquatic food-chain dynamics are similar to those previously described for terrestrial ones. On the whole, the actinides have no known biological function and do not show an affinity for muscle in higher trophic level organisms (Poston and Klopfer 1988). In a study conducted at the Savannah River Plant by Whicker et al. (1990), aquatic macrophytes were found to have the highest concentration ratio, primarily, the authors suggest, due to adsorption of sediment particulates to surfaces. All other trophic levels were found to have very low concentration ratios. In nearly all cases, concentrations of transuranics in vertebrate tissues were very low. One would expect very low concentrations of transuranics in vertebrate tissues because of the low concentrations in water, sediments, macrophytes, and invertebrates, and because of the generally low food-chain transfer factors of most transuranics (Bair and Thompson 1974, Eyman and Trabalka 1980).

Only 5 to 10 percent of the plutonium and americium in sediments in a process waste pond on the Hanford Reservation were found to be available for foodweb transfer (Emery et al. 1975). The remaining fraction appeared to be tightly bound to particles and would be transported ecologically in particulate form. Watercress had a Pu concentration about equal to the sediments while dragonfly larvae and snails had americium (Am) levels approximating the sediments. All remaining biota had Pu and Am concentrations which were generally well below those of the sediments. Goldfish in the pond concentrated small amounts of both isotopes.

With respect to the distribution of several long-lived radionuclides within aquatic ecosystems, the work of Whicker et al. (1990) tends to confirm and strengthen the concept that many radionuclides tend to reside entirely in the sediments. It appears that this is true for ^{137}Cs and the transuranium elements. The rule also seems to hold for different types of systems with widely varying limnological properties. As a consequence, only a very small fraction of the total system inventory can reside in the biotic components. For radionuclides that tend to sorb strongly to sediments, this distribution can probably be extended to most freshwater ecosystems.

9.1.2.3 Organic Compounds

Most of the organic compounds found at OU6 (Table 9-1) are on the RCRA Appendix VIII and IX Lists, the Superfund Target Compound List, and the EPA Clean Water Act Priority Pollutants Compounds List. Each is known to cause adverse acute and chronic effects on aquatic life depending on concentration. All of these compounds, except aldrin, were detected in surface water at OU6 (Tables 2-2 through 2-12). Values for each of these compounds are below the potential chemical-specific ARARs reported in Tables 3-1, 3-2, and 3-3 of this document. While these contaminants do not appear to be of concern based on these limited data, forthcoming data will be evaluated with respect to this determination.

Chemicals which are readily accumulated by aquatic biota and are persistent in aqueous media, such as the polycyclic aromatic hydrocarbons (e.g., napthalene and phenanthrene) and pesticides (e.g, aldrin) will require evaluation of their potential adverse effects on site-specific biota. While there is no history of their disposal, detection of pesticides, PCBs, or dioxins in the Phase I analytical program for abiotic media would also warrant further consideration in this environmental evaluation. Locations of elevated levels of organic chemicals detected in groundwater will warrant evaluation due to the potential interaction with surface water and subsequent potential for exposure to receptor organisms.

9.1.3 Protected Wildlife, Vegetation and Habitats

9.1.3.1 Wildlife

The U.S. Fish & Wildlife Service has identified several listed endangered or threatened wildlife species which could possibly occur in the Rocky Flats Plant area. However, none is expected to occur because of lack of habitat. These species include the endangered bald eagle *(Haliaeetus leucocephalus)*, the two threatened subspecies of peregrine falcon *(Falco peregrinus tundris* and *F. p. anatum*), the endangered whooping crane *(Grus americana)* and the endangered black-footed ferret *(Mustela nigripes)*.

The bald eagle is primarily a winter resident around rivers and lakes, and the closest known nesting pairs are found at Barr Lake, 25 miles to the east of Rocky Flats. Although the Rocky Flats Plant Site lacks suitable bald eagle nesting habitat, bald eagles have been observed over the plant site, and one pair has been observed feeding regularly at Great Western Reservoir, located approximately 0.4 miles east of the site.

The whooping crane passes through Colorado during its spring and fall migrations. Whooping cranes, blown off their migration course, could use the Rocky Flats area as a night roost. These birds prefer large marshes and wetlands in broad open river bottoms and prairies. Such habitat is not present at Rocky Flats.

The two subspecies of peregrine falcon may occasionally occur in the Rocky Flats area as they hunt for prey. Nesting preferences are high cliff sides and river gorges, both of which are absent at Rocky Flats. However, nesting sites have been recorded to the west about 4 to 5 miles from the site.

The historical geographic range of the black-footed ferret coincides with that of prairie dogs, a principal prey species. Although black-footed ferret populations are now extinct in the wild, large prairie dog towns sufficient to support a black-footed ferret population (>80 acres for black-tailed prairie dogs) if found at Rocky Flats would be surveyed by approved methods (U.S. Fish and Wildlife 1986).

Several additional species are of special interest to the State of Colorado because they are endangered in the state, are game species, have small and/or declining populations, or are pest/nuisance species (Colorado Division of Wildlife 1981, 1982a, 1982b and 1985). These species will be identified and investigated during Task 2 and will be considered in the development of on-site food webs.

9.1.3.2 <u>Vegetation</u>

Ten federally-listed or proposed plant species occur in Colorado, all of which are western slope species. None of these is known or expected to occur on or near Rocky Flats. A number of candidate species for federal listing are known to occur in Jefferson and Boulder Counties, but have not been identified at Rocky Flats.

9.1.3.3 <u>Wetlands</u>

Numerous regulations and acts have been promulgated to protect water-related resources, including wetlands. Wetlands play an important role in ecosystem processing and in providing habitat to a variety of plant and animal species. An assessment of Rocky Flats wetlands was completed in 1989 (EG&G 1990h); these wetlands currently fall under the jurisdiction of the U.S. Army Corps of Engineers. Wetlands occur along North and South Walnut Creek, the Unnamed Tributary, and around the A- and B-series Ponds. DOE activities with a potential to impact wetlands will follow regulations designed for their protection.

9.2 ENVIRONMENTAL EVALUATION TASKS

An environmental evaluation at OU6 is necessary for Rocky Flats Plant to meet the requirements of Sections 121(b)(1) and (d) of CERCLA. An environmental evaluation, in conjunction with the human health risk assessment, is required to ensure that remedial actions are protective of human health and the environment. Guidelines for conducting this evaluation, which is also called an ecological assessment, are provided by EPA in <u>Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual</u> (U.S. EPA 1989e). Additional guidance is derived from EPA's <u>Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document</u> (U.S. EPA 1989d) and other guidance documents (Table 9-3).

The environmental evaluation is both a qualitative and quantitative appraisal of the actual or potential injury to biota other than humans and domesticated species due to contamination at OU6. The environmental evaluation is intended to reduce the inevitable uncertainty associated with understanding the environmental effects of contaminants present in OU6 and to give more definitive boundaries to that uncertainty during remediation.

TABLE 9-3

EXAMPLES OF EPA AND DOE GUIDANCE DOCUMENTS AND REFERENCES FOR CONDUCTING ENVIRONMENTAL EVALUATIONS

Barnthouse, L.W., G.W. Suter, S.M. Bartell, J.J. Beauchamp, R.H. Gardener, E. Linder, R.V. O'Neill and A.E. Rosen. 1986. User's Manual for Ecological Risk Assessment. Environmental Sciences Division. Publication No. 2679, ORNL-6251.

U.S. DOE. 1988a. Comprehensive Environmental Response, Compensation, and Liability Act Requirements. DOE Order 5400.YY. Draft, September 1988.

U.S. DOE. 1988b. Radiation Effluent Monitoring and Environmental Surveillance. DOE Order 5400.XY, Draft, September 1988.

U.S. DOE. 1990b. Radiation Protection of the Public and the Environment. DOE Order 5400.5

U.S. EPA. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. Office of Emergency and Remedial Response, Washington D.C., EPA/540/g-89/004.

U.S. EPA. 1988c. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/2-88/003.

U.S. EPA. 1988e. Superfund Exposure Assessment Manual. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-88/001.

U.S. EPA. 1989c. Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-89/043.

U.S. EPA. 1989d. Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document. Office of Research and Development. EPA/600/3-89/013.

U.S. EPA. 1989e. Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual. Interim Final. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/001.

U.S. EPA. 1990. Guidance for Data Useability in Risk Assessment. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/G-90/008.9.2.1 Task 1: Preliminary Planning

The following plan for OU6 provides a framework for the review of existing data, the conduct of subsequent field investigations, and the preparation of the contamination assessment. Methodologies for the ecological and ecotoxicological field investigations (Tasks 3 and 9) are described in the Field Sampling Plan presented in Subsection 9.3.

9.2.1 Task 1: Preliminary Planning

This task includes a definition of the study area, a determination of the scope of the environmental evaluation, identification of DQOs, and a plan for obtaining consensus on selection criteria for contaminants of concern, key receptor species, reference areas, and the field sampling approach/design.

The scope of the environmental evaluation will describe the kind and amount of information that will be collected in the study. The biological parameters that are to be measured, estimated, and calculated will be described. The time period and boundaries of the evaluation will be designated. Depending on the available pathways for exposure and the habitats potentially exposed to contamination, the study area for this ecological assessment may extend beyond the boundaries of OU6.

9.2.1.1 Selection Criteria for Contaminants of Concern

Because not all chemicals found at OU6 will have adverse effects on biota, the list of chemicals to be evaluated can be narrowed. Chemical and species-specific criteria (e.g., likelihood of exposure) will be used for selecting those contaminants that are of particular concern from an ecological perspective at OU6. Chemical, physical, and toxicological criteria will be used in selecting contaminants of concern. Examples of the potential criteria to be evaluated in selecting contaminants of concern are shown in Table 9-4.

Although the selection process for contaminants of concern parallels that for the Human Health Risk Assessment, the lists may differ somewhat based on contaminant fate and transport characteristics and species-specific toxicities. Selection of the contaminants of concern will be evaluated in accordance with EPA guidance (U.S. EPA 1989e). The screening values for each the criteria will be used as tools to help select chemicals that need further assessment. They will not be used as limits which indicate absolute "no adverse effects" levels. Actual site-specific conditions will determine the potential for adverse effects in receptor species at OU6.

TABLE 9-4

POTENTIAL SELECTION CRITERIA FOR CONTAMINANTS OF CONCERN

Concentrations detected on site
Frequency of detection
Historical disposal information
- Type
- Quantity

Mobility in environmental media
Chemical fate (transport)
- Adsorption coefficient
- Partition coefficient (water-octanol)
- Water solubility
- Vapor pressure

Persistence
- Biodegradation
- Chemical degradation

Bioaccumulation potential
Bioavailability
Biotransformation potential
Background concentrations
Biochemistry
- Essential nutrient
- Enzyme inhibitor

Toxicity
Treatability

9.2.1.2 Identification of Key Receptor Species

Key receptor species are those species which are or may be sensitive to the particular contaminants of concern. Species at each trophic level within a food web, differ in their sensitivity and the ways they take in, accumulate, metabolize, distribute, and expel contaminants. The susceptibility of a particular organism also varies with the mechanism through which contaminants are taken up from the environment. In general, the following criteria determine the susceptibility of the species to a particular contaminant (U.S. EPA 1989e):

- Rapidity with which the contaminant is absorbed from the environment
- Sensitivity of species' tissues to the dosage incurred
- Relationship between tissue sensitivity and the expression of symptoms of toxic injury
- Rapidity of repair or accommodation to the toxic injury

Selection of receptor species will depend on the ability to detect toxic injury in the organism or subsequent adverse effects to the population. National standards on the definitions of injury to biological receptors are found in the Natural Resource Damage Assessment Rule [40 CFR Subtitle A Section 11.62 (f)]. These include death, disease, behavioral abnormalities, cancer, physiological malfunctions, and physical deformation. Additional methods for detecting injury to biological resources are provided in the Type B Technical Information Document: Injury to Fish and Wildlife Species (U.S. Department of the Interior 1987). The procedures described in these documents provide a framework for determining what categories of effects might be observed in the field during the site visit and subsequent surveys and for selecting appropriate study methods to establish relationships between contaminant distribution and concentration in the physical environment and biological consequences in the receptor species and populations (Reagan and Fordham 1991). By using this approach to focus efforts on examining specific effects in key receptor species, costs and sampling efforts will be reduced.

Selection of key receptor species is in part a subjective decision based on species dominance or judged importance in the food chain. Selection criteria for key receptor species will include consideration of the following:

- Species' sensitivity
- Listing as rare, threatened, or endangered by a governmental organization
- Game species

- A key component of ecosystem structure and function (e.g., abundant prey for other important species

Additional criteria used in the selection of key receptor species include species' habitat preferences, food preferences and other behavioral characteristics which can determine population size and distribution in an area or significantly affect the potential for exposure. Key receptor species may include game species such as mule deer *(Odocoileus hemionus)* which is mobile and has a large home range; or an organism that is sedentary or has a more restricted movement such as plants, some invertebrates, and some small vertebrates. For contaminants that bioaccumulate, the effects are usually most severe for organisms at the top of the food chain (e.g., top predators). Examination of contaminant effects on these more mobile species may necessitate the integration of data from different OUs.

A checklist of OU6 biota will be developed in conjunction with the ecological field inventory. The initial list of key receptor species will be chosen from the checklist based on the selection criteria and will include organisms from each trophic level. The documented selection analysis will include an evaluation of the species' relation to potential contaminant exposure through both direct contaminant accumulation from the abiotic environment and bioaccumulation through the food chain. Examples of key receptors species likely to be on this list are presented in Table 9-5. This list will be refined as information is evaluated on known contaminant effects on these species (or similar species) and the documented levels of contamination present at the site.

Key receptor species will be selected from this list for subsequent detailed food web analyses and possible tissue sampling. Selection of key receptor species for tissue analyses will depend on the species' suitability for sampling, sample size requirements, results of the preliminary exposure assessment, and expectation for finding contaminants in the tissues sampled (see Subsections 9.2.9 and 9.2.10).

Final selection of contaminants of concern and key receptor species will provide the basis for the contamination assessment (Tasks 4 through 7). In the contamination assessment, food webs and contaminant exposure pathways will be developed for OU6. Information on these food webs will be used to relate quantitative data on contaminants in the abiotic environment to adverse effects in biota and to evaluate potential impacts to biota due to contaminant exposure.

TABLE 9-5

POTENTIAL KEY BIOLOGICAL RECEPTORS FOR ASSESSMENT OF ECOLOGICAL IMPACTS AT OU6

Community	Receptor Species
Periphyton	Green algae Blue-green algae
Benthic Macroinvertebrates	Mayflies (larvae) Caddis flies (larvae) Chironomids (larvae) Crayfish
Fish	Fathead minnow Bluegill
Reptiles	Garter snake Bull snake
Mammals	Deer mouse Northern pocket gopher Microtines Rabbit Coyote
Birds	Mourning dove Mallard Killdeer Red-winged blackbird Ring-necked pheasant Cormorant Blue heron Great-Horned owl
Terrestrial Invertebrates	Earthworms Grasshoppers
Grasses	Western wheatgrass Blue grama Cheatgrass
Shrubs/Forbs	Snowberry Willows Bindweed Sunflower Cattails Pondweed
Microbial Populations	Entire population

9.2.1.3. Reference Areas

Determination of criteria for selection and sampling of reference areas will be coordinated between operable units. Reference areas will be identified as needed for terrestrial, wetland, and aquatic species and will be selected based on measurement endpoints. Reference areas are likely to be selected to the west or north of RFP, away from potential effects associated with releases from either RFP or OU6.

Reference areas may be selected when current and historical data are not available to assess impacts from OU6 contaminants. One or more reference areas may be selected based upon their similarity to OU6, their lack of exposure to contamination from Rocky Flats or other sources, and the selected measurement endpoint. If more than one habitat or ecosystem type (e.g., terrestrial and aquatic) is to be assessed at OU6, comparable reference areas may be established for each, or a reference area may be selected containing those habitats or ecosystem types in a comparable distribution. For OU6, at least one reference area may be located upstream of the assessment area unless conditions indicate the area is unsuitable as a reference area. Data collected at the reference area will be compared where possible to values reported in the scientific literature to demonstrate that the data represent a normal range of conditions. Methods used to collect data at the reference area will be comparable to those used at OU6.

The selection of reference areas would be made to meet DQOs (U.S. EPA 1989e) and the selected assessment and measurement endpoints. Two basic criteria would be employed in the selection and establishment of reference areas:

1. The reference areas will be similar to OU6 in terms of soil series, topography, aspect, vegetation, habitat types, and plant and animal assemblages.

2. The reference areas, including vegetation and wildlife, have not been impacted by releases from OU6 or other RFP Operable Units.

9.2.1.4 Data Quality Objectives

The DQO development process will follow the three stages recommended by EPA (1989d). Stage I of the DQO process involves preparing definitions and concise DQOs. Examples of Stage I program DQOs for this environmental evaluation include the following:

- Identify appropriate site-specific receptor species, contaminants of concern, and exposure pathways to determine if there is a potential for adverse effects to occur as a result of contamination. This step includes determination of relevant contaminant concentrations in biological tissues.

- Evaluate the potential for impacts to occur to biological resources outside the boundaries of OU6 or Rocky Flats Plant.

- Evaluate the need for remediation to protect the environment.

Stages II and III of the DQO process include identification of data uses and needs and design of the data collection program. Products of Stage II include proposed statements of the type and quality of environmental data required to support the DQOs, along with other technical constraints on the data collection program. The objective of Stage III is to develop data collection plans that will meet the criteria and constraints established in Stages I and II. Stage III results in the specification of methods by which data of acceptable quality and quantity will be obtained. The DQO development process will continue as scoping of the environmental evaluation becomes more refined. Additional Stage I decision-type DQOs may be needed or data collection-type DQOs may be modified based on Task 1 and Task 2 results and subsequent refinement of the field sampling plan.

9.2.1.5 Field Sampling Approach/Design

In addition to the work plan, proper conduct of this environmental evaluation will depend upon design of the Field Sampling Plan. The Field Sampling Plan presented in Subsection 9.3 is designed to be flexible so that it can be revised as additional data are collected. Flexibility in the Field Sampling Plan will ensure that field data collection activities will be comparable to and compatible with previous data collection activities performed at the site while providing a mechanism for planning and approving new field activities. The Field Sampling Plan, in conjunction with Standard Operating Procedures (SOPs)(in preparation by EG&G) for Ecology (Volume V) and the Implementation Plan (in preparation by EG&G), will provide guidance for all field work by defining the sampling and data-gathering methods to be used on the project.

9.2.2 Task 2: Data Collection/Evaluation and Preliminary Risk Assessment

As an integral part of the RFI/RI process, Task 2 of the environmental evaluation will focus on accumulating and analyzing pertinent information on three major areas:

- Species, populations, and food web interrelationships

- Types, distribution, and concentrations of contaminants in the abiotic environment (e.g., soil, surface water, groundwater, and air)

- Preliminary determination of potential exposure pathways and potential contaminant effects on OU6 biota based on literature review

The principal subtasks in Task 2 include Literature Review and Site Characterization. These subtasks will be performed in conjunction with the Task 3, Ecological Field Investigation. Information that will be developed from these tasks includes the following:

- Chemical inventory/contaminants of concern - Existing information including that obtained on chemical contaminants from other investigations at Rocky Flats and other DOE facilities will be used in the development of a preliminary list of contaminants of concern.

- Initial toxicity test data - Preliminary data on the toxicity of potentially complex chemical mixtures in OU6 surface waters.

- Descriptive field surveys - Inventory of OU6 biota and locations of obvious zones of chemical contamination, ecological effects, and human disturbance.

- Species inventory - Plant and animal species known to occur within OU6 or to potentially contact contaminants at OU6 and their trophic relationships.

- Population characteristics - General information on the abundance of key species.

- Food habit studies - Available information from literature sources to supplement field observations and possible gut content analysis on key species.

9.2.2.1 Literature Review

As an essential part of Task 2, a review of available documents, aerial photographs, and data relevant to the site will be completed. This will allow compilation of a database from which to determine data gaps and to provide evidence for a defensible field sampling program. Prior studies by DOE and the RFP operating contractors will be reviewed and evaluated. Information to be reviewed will include the following:

- Project files maintained by Rockwell International and EG&G

- Project reports and documents on file at Front Range Community College Library and the Colorado Department of Health

- DOE documents and DOE orders

- The Phase I database

- The Rocky Flats EIS database

- Data from ongoing environmental monitoring and National Pollution Discharge Elimination System (NPDES) programs

- Studies conducted at Rocky Flats on radionuclide uptake, retention and effects on plant and animal populations

- Scientific literature, including ecological and risk assessment reports, from other DOE facilities (Oak Ridge National Laboratory, Los Alamos, Hanford, Savannah River, Fernald)

If available and applicable, historical data will be used. Where the same methods are not used in the collection of new data, use of historical data will depend on the demonstrated comparability of the data collection methods.

9.2.2.2 Site Characterization

Environmental resources at the site will be characterized based on reviews of existing literature and reports, including results from the Phase I RFI/RI investigation, other operable unit RFI/RI investigations, and the Task 3 ecological field investigation. The description of the site will be presented in terms of the following distinct resource areas:

- Meteorology/Air Quality
- Soils
- Geology
- Surface and Groundwater Hydrology
- Terrestrial Ecology
- Aquatic Ecology
- Protected/Important Species and Habitats

The purpose of the site characterization is to describe resource conditions as they exist without remediation. The narrative with supporting data will include descriptions of each resource, with attendant tables and figures, as appropriate, to depict, in a concise and clear fashion, site conditions, particularly as they influence contaminant fate and transport.

Included in this task is the development of a community food web model (Reagan and Fordham 1991) to describe the feeding relationships of organisms at Rocky Flats Plant. Food web construction begins with gathering information to evaluate the food habits of species or species groups (e.g., grasshoppers) found or potentially occurring on site. Standard computer searches will be augmented with searches of local university libraries to locate any regionally pertinent studies on food habits. The preliminary list of important species, compiled from background information, will be completed based on observations of presence and abundance made during the ecological site surveys and on trophic level data obtained from the food web model. Based on the model, a modified list of species will be made using toxicological information (toxicity assessment) to determine which species or species groups might be most affected or most sensitive to the chemical(s) of interest.

Data from past studies and preliminary data from current environmental studies will be used to better define the present distribution of contaminants in the abiotic environment and to develop an initial food web model. The food web model in conjunction with a preliminary pathways analysis will identify likely or presumed exposure pathways or combinations of pathways and receptor species at risk. Based on this preliminary information, the Task 3 and Task 9 field investigation sampling approach/designs may be revised.

9.2.3 Task 3: Ecological Field Investigation

The Phase I field investigation for OU6 consists of the following separate programs: the air program which will entail emissions estimation and modeling; the soils, surface water, and groundwater programs, which will be conducted as part of the Phase I RFI/RI activities; and the terrestrial and aquatic biota sampling program, which will be conducted as part of this environmental evaluation.

9.2.3.1 Air Quality

A site-wide air quality monitoring program is being conducted at Rocky Flats. These data can be used to model airborne transport of contaminants to potential receptors. Where the inhalation pathway is considered to be significant in the case of OU6 biota, a detailed pathways analysis and assessment of potential adverse effects using these transport model data will be performed.

9.2.3.2 Soils

Few data exist on contaminants present in surficial materials at OU6. Groundwater monitoring wells have been installed at several locations within the drainages and in several IHSSs. Soil samples from various depths in these wells were analyzed. All of these data have not been validated, and there is some uncertainty in the unvalidated data.

The purpose of the Phase I RFI/RI sampling and analysis program is to provide data for characterizing the IHSSs and for confirming the presence or absence of contamination. The Phase I RFI/RI Work Plan proposes to collect soil samples from each of the IHSSs at OU6. Soil samples will be collected from the surface (< 2 inches deep) in the Sludge Dispersal, Old Outfall, Triangle, Spray Field, and Soil Dump areas. Surface soils samples will be analyzed for radionuclides and metals at the Sludge Dispersal, Old Outfall and Spray Field areas and for radionuclides only at the Triangle and Soil Dump areas. Soil samples will also be collected from borings at the Old Outfall, Trenches, Soil Dump and Spray Field areas and only where there are radiation hotspots or high soil gas readings in the Triangle. The list of soil analysis parameters is presented in Table 7-9 and the planned analytical program is presented in Table 7-10. In addition to these analyses, soil analyses will be conducted in the field and laboratory to confirm and clarify Soil Conservation Service descriptions and classifications. This information will be used to evaluate suitability of the soils for plant growth and to assist in the selection of suitable reference areas.

Surficial soil samples will be of prime importance for determining source contaminants for biota. This uppermost layer is a major source of nutrients and contaminant uptake for the vegetation under study and is also a potential source of contaminant ingestion to wildlife. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through the soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater than 20 feet (maximum depth of burrowing animals and plant root penetration) will not be considered to affect biota.

The sampling and analysis programs under the Phase I RFI/RI field investigations will be reviewed and modified as necessary to ensure that sampling intervals and methods are appropriate to collect surficial soil samples in the required locations. Data from other operable unit programs will be evaluated for use in characterizing the nature and areal extent of surface soil contamination in the vicinity of OU6. The information will be used to help identify exposure pathways for the environmental assessment.

9.2.3.3 <u>Surface Water and Sediments</u>

Surface water and sediment samples are collected on a regular basis as part of ongoing site-wide investigations. These investigations will continue. This Phase I RFI/RI Work Plan proposes extensive sampling along Walnut Creek and in the A- and B-Series Ponds. In addition, samples will be collected upstream of the Rocky Flats Plant to provide background data. Samples will be analyzed for metals, radionuclides, inorganics, and organics. Data on physical parameters such as sediment composition and quality, grain sizes, and total organic carbon will also be collected.

Surface water sampling and analytical results presented in other operable unit work plans and reports will be evaluated with respect to this environmental evaluation plan. Sampling locations presented in this work plan are integrated with ongoing site-wide sampling locations. Chemical results from other operable unit surface sampling locations will be reviewed and incorporated into the OU6 environmental evaluation as appropriate.

9.2.3.4 Groundwater

Groundwater monitoring wells upgradient, downgradient or within some of the IHSSs provide limited information on groundwater conditions at OU6. This Phase I RFI/RI proposes to install additional monitoring wells downgradient of the Sludge Dispersal, Trenches, Spray Field areas, and Ponds A-4 and B-5, and within the Triangle Area. The laboratory analytical results will be used to assess the presence or absence of groundwater contamination and to assess the exposure pathway, if present.

Data from other operable unit programs will aid in characterizing the nature and areal extent of groundwater contamination in the vicinity of the site. The hydrogeologic information and laboratory analytical results from these planned boring and well installation programs will likewise be incorporated in this environmental evaluation where applicable. The information will be used to assist in determining the nature and extent of contamination in shallow groundwater and help identify exposure pathways for the environmental assessment.

9.2.3.5 Terrestrial and Aquatic Biota

Terrestrial and aquatic species in the Rocky Flats Plant area have been described by several researchers (Weber et al. 1974; Clark 1977; Clark et al. 1980; Quick 1964; Winsor 1975; CDOW 1981; CDOW 1982a, 1982b); most of these reports are summarized in the Final EIS (U.S. DOE 1980). In addition, terrestrial and aquatic radioecology studies conducted by CSU and DOE (Rockwell International 1986e; Paine 1980; Johnson et al. 1974; Little 1976; Hiatt 1977) along with annual monitoring programs at Rocky Flats Plant have provided information on the plants and animals in the area and their relative distribution.

Limited field surveys will be conducted in Task 3 to characterize current biological site conditions in terms of species presence, habitat characteristics and/or community organization. The emphasis will be to describe the structure of the biological communities at OU6 in order to identify potential contaminant pathways, biotic receptors, and key species.

Initial aquatic toxicity tests using *Ceriodaphnia spp.* and fathead minnows will be conducted under Task 3 to provide an initial determination of the toxicity of potentially complex chemical mixtures in OU6 surface water. Standardized EPA acute and chronic test methods will be followed in accordance with NPDES toxicity testing procedures currently being used at Rocky Flats.

Vegetation

The objectives of the vegetation sampling program are to provide data for: (1) the description of site vegetation characteristics; (2) identification of potential exposure pathways from contaminant releases to higher trophic-level receptors; (3) selection of key species for contaminant analysis to determine background conditions for OU6; and (4) identification of any protected vegetation species or habitats.

A number of habitat types are expected to be found in the Walnut Creek Drainage (Clark et al. 1980). Grasses characteristic of the short grass plains are expected to be abundant. Representative species include blue grama *(Bouteloua gracilis)*, Junegrass *(Koeleria cristata)*, dropseed *(Sporobolus spp.)*, slender wheatgrass *(Agropyron trachycaulum)*, and green needlegrass *(Stipa viridula)*, which are interspersed with other grasses, shrubs, and a variety of annual flowering plants. Transects will be established at each of the IHSSs, along the Unnamed Tributary and along North and South Walnut Creek to collect phytosociological data on density, cover, biomass, frequency, and species presence.

Wetland Vegetation

Wetlands have been identified along the Unnamed Tributary and North and South Walnut Creek (EG&G 1990h). These occur as linear wetlands that support hydrophytic vegetation species including sandbar willow *(Salix exigua)*, american watercress *(Barbarea orthoceras)*, and plains cottonwood *(Populus sargentii)*. Other species associated with these wetlands include broad-leaf cattail *(Typha latifolia)*, baltic rush *(Juncus articus)*, cordgrass *(Spartina pectinata)*, silver sedge *(Carex praegracilis)*, and various bulrushes *(Scirpus spp.)*. Transects will be established in wetland vegetation habitats to collect phytosociological data on density, cover, biomass, frequency, and species presence.

Periphyton

The periphyton community is a closely-adhering group of organisms that form mat-like communities on rocks, other solid objects, or the stream bottom. The community is composed of algae, bacteria, fungi, detritus, and other macroscopic heterotrophic organisms. Because of the large surface-to-volume ratio of its constituents, periphyton have been found to be an excellent indicator community for accumulation of contaminants. Periphyton samples will be collected at designated locations in OU6 (see Subsection 9.3.2.2).

Periphyton communities provide a sensitive mechanism to detect changes in aquatic environments that result from the introduction of contaminants. Taxonomic composition and relative abundance of periphyton can be measured on natural substrates as well as standardized artificial substrates. On hard artificial substrates, data on algal abundance, biomass, and species composition will be obtained by removing the substrate and by scraping or brushing the flora from a measured area into a container.

Benthic Macroinvertebrates

Benthic macroinvertebrates may exist in rocky/gravelly substrates or as soft bottom communities along portions of the Unnamed Tributary, North and South Walnut Creek, and the A- and B-Series Ponds. The soft-bottom benthos are those macroscopic invertebrates inhabiting mud or silt substrates, whereas the immature stages of insects inhabit rock surfaces, rooted stems, and leaves or gravelly substrates. Because these communities are essentially stationary, they are good indicators of past and present habitat contamination. Additionally, their feeding methods (filtering microscopic organisms and fine materials, preying on smaller invertebrates, and grazing periphyton), suggest that benthic species are ingesting other organisms that are potentially concentrating contaminants. Designated locations for sampling benthic macroinvertebrates are presented in Subsection 9.3.2.2.

Fish

Fish can be important components of ecological assessments because they are relatively long-lived, occupy upper trophic levels of aquatic ecosystems, and they may spend their entire lives in relatively small areas. Fish species representing both herbivores and carnivores are likely present in OU6 aquatic habitats and may demonstrate biomagnification of contaminants within the creek or pond ecosystem. The aquatic survey will document species present and their trophic relationships.

Terrestrial Wildlife

A field survey will be conducted to gather data on animal communities at Walnut Creek Drainage. The objective of the animal life survey is to: (1) describe the existing animal community at Walnut Creek Drainage; (2) identify potential contaminant pathways through trophic levels; (3) develop food web models including contribution from vegetation; (4) identify key species for potential collection and tissue analysis; and (5) identify any protected species.

The field survey will document the presence of terrestrial species and allow for a general description of the community. Some species (e.g., songbirds, larger mammals, reptiles, and raptors) may use the area daily, seasonally or sporadically, or wander through as vagrants. Survey timing and techniques will consider these uses.

9.2.4 Contamination Assessment (Tasks 4 through 7)

The contamination assessment includes Tasks 4 through 7. The two major objectives of the contamination assessment are to:

- Obtain quantitative information on the types, concentrations, and distribution of contaminants in selected species

- Evaluate the effects of contamination in the abiotic environment on ecological systems

Conducting a contamination assessment requires an evaluation of chemical and radiological exposures and the subsequent toxicological effects on key species. Of specific importance in the contamination assessment are the identification of exposure points, the measurement of contaminant concentrations at those points, and the determination of potential impacts or injury. Impacts may result from movement of contaminants through ecological systems or from direct exposure (inhalation, ingestion, or deposition).

The Contamination Assessment for OU6 will be based on existing environmental criteria, published toxicological literature, and existing, site-specific environmental evaluations. The program design will be integrated with other ongoing RFI/RI studies so that concentrations of contaminants in abiotic media can be related to contaminant levels and effects in biota. A preliminary contamination assessment will be made in Task 2 based on the site characterization and contaminant identification activities. The preliminary Task 2 assessment will be used to revise the Task 9 ecotoxicological field investigation sampling design. The contamination assessment process described in the following tasks will include the development of a site-specific pathways model to quantify the potential for contaminant exposure and adverse effects in biota.

The objectives and description of work for each of the contamination assessment tasks is described below.

9.2.5 Task 4: Toxicity Assessment

This assessment will include a summary of the types of adverse effects on biota associated with exposure to site-related chemicals, relationships between magnitude of exposures and adverse effects, and related uncertainties for contaminant toxicity, particularly with respect to wildlife. Ecological receptor health effects will be characterized using EPA-derived critical toxicity values when available in addition to selected literature pertaining to site- and receptor-specific parameters.

The toxicity assessment will provide brief toxicological profiles centered on health effects information on wildlife populations. The profiles will cover the major health effects information available for each contaminant of concern. Data pertaining to wildlife species will be emphasized, and information on domestic or laboratory animals will be used when wildlife data are unavailable.

9.2.6 Task 5: Exposure Assessment and Pathways Model

This task will identify the exposure or migration pathways of the contaminants, taking into account environmental fate and transport through both physical and biological means. Each pathway will be described in terms of the chemical(s) and media involved and the potential ecological receptors. The exposure assessment process will include the following three subtasks:

- Identify exposure pathways
- Determine exposure points and concentrations
- Estimate chemical intake for receptors

Each of these subtasks is described below.

9.2.6.1 Exposure Pathways

The purpose of this subtask is to qualitatively identify the actual or potential pathways by which various biological receptors at or near OU6 might be exposed to site-related chemicals or radionuclides. The exposure pathway analysis will address the following four elements:

- A chemical/ radionuclide source and mechanism of release to the environment

- An environmental transport medium (e.g., soil, water, air) for the released chemical/ radionuclide

- A point of potential biological contact with the contaminated medium

- A biological uptake mechanism at the point of exposure

All four elements must be present for an exposure pathway to be complete and for exposure to occur. Exposure pathways will be evaluated and modeled, where possible. Toxicity tests, such as those proposed for Task 3, can be used to conduct a direct effects-related investigation. Additional toxicity tests may be designed based on the pathways model results.

9.2.6.2 Determination of Exposure Points and Concentrations

The identified exposure points are those locations where key ecological receptor species may contact the contaminants of concern. Potential for exposure depends on characteristics of the contaminant, the organism, and the environment. Determination of exposure points entails an analysis of key receptor species, locations, and food habits in relation to potential contaminant exposure both through direct contaminant accumulation or deposition from the abiotic environment and through indirect bioaccumulation. The exposure assessment for OU6 will provide information on the following:

- What organisms are actually or potentially exposed to contaminants from OU6
- What the significant routes of exposure are
- What amounts of each contaminant organisms are actually or potentially exposed to
- Duration of exposure
- Frequency of exposure
- Seasonal and climatic variations in conditions which are likely to affect exposure
- Site-specific geophysical, physical, and chemical conditions affecting exposure

A determination of the nature and extent of contamination in the abiotic media (air, soils, surface water, and groundwater) is presented in this Phase I RFI/RI Work Plan for Walnut Creek Drainage. Phase I data, when available, will be summarized and used to characterize source areas and release characteristics at the site. The exact exposure points can be expected to vary depending on both the contaminant and the key receptor species under consideration.

Concentrations of chemicals that are likely to have the greatest impact (based on concentration in the environment, toxicity values, and biological uptake) will be determined by environmental fate and transport modeling or actual environmental media sampling for each exposure point. Fate, transport, and endpoint contamination levels will be modeled using environmental multi-media risk assessment models. Such models can provide the potential maximum concentrations of chemicals at the exposure points by which to evaluate the "worst-case" scenario.

9.2.6.3 Estimation of Chemical Intake by Key Receptor Species

This step includes an evaluation of key receptor species' contaminant uptake by direct routes (i.e., inhalation, ingestion, dermal contact) and indirect routes (bioconcentration, bioaccumulation, biomagnification). The amounts of chemical and radiological uptake will be estimated using appropriate conservative assumptions, site-specific analytical data, and forthcoming guidance from EPA's Wildlife Exposure Factors Handbook (to be published in 1991). A pathways analysis model (Reagan and Fordham 1991; Thomann 1981) will be used to establish relationships between concentrations of a chemical in different media with concentrations known to cause adverse effects.

Direct measurement of contaminant uptake through tissue analyses will be conducted during Task 9 of the environmental evaluation. Such site-specific data and field observations will be used to reduce uncertainty in the pathways model and strengthen interpretation of the overall study.

9.2.7 Task 6: Contamination Characterization

Contamination characterization entails the integration of exposure concentrations and reasonable worst-case assumptions with the information developed during the exposure and toxicity assessments to characterize current and potential adverse biological effects (e.g., death, diminished reproductive success, reduced population levels, etc.) posed by OU6 contamination. The potential impacts from all exposure routes (inhalation, ingestion, and dermal contact) and all media (air, soil, groundwater, and surface water/ sediment) will be included in this evaluation as appropriate according to EPA guidance (U.S. EPA 1989c).

Characterization of adverse effects on receptor species and their populations is generally more qualitative in nature than characterizing human risks. This is because the toxicological effects of most chemicals have not been well documented for most ecological species. Criteria that are usable and applicable for the evaluation of ecological effects are generally limited. EPA AWQC and Maximum Allowable Tissue Concentrations are the most readily available criteria. Criteria found in federal and Colorado state laws and regulations pertaining to the preservation and protection of natural resources can also be used. Criteria may also be derived from information developed for use under other environmental statutes, such as the Toxic Substances Control Act or the Federal Insecticide, Fungicide and Rodenticide Act. An attempt will be made to consider the adverse effects of chemicals on populations and habitats rather than on individual members of a species according to EPA guidance (U.S. EPA 1989e, 1989d). Where specific information is available in the published literature, a more quantitative evaluation of effects will be made using the site-specific pathways model. This approach is in agreement with EPA guidance (U.S. EPA 1989e).

9.2.8 Task 7: Uncertainty Analysis

The process of assessing ecological effects is one of estimation under conditions of uncertainty. To address uncertainties, the OU6 environmental evaluation will present each conclusion, along with the issues that support and fail to support the conclusion, and the uncertainty accompanying the conclusion. Factors that limit or prevent development of definitive conclusions will also be discussed. In summarizing the assessment data, the following sources of uncertainty and limitations will be specified:

- Variance estimates for all statistics

- Assumptions and the range of conditions underlying use of statistics and models

- Narrative explanations of other sources of potential error

Validation and calibration of the pathways model will also be performed where practicable.

9.2.9 Task 8: Planning

Task 8 will include planning for tissue analysis studies and any additional ecotoxicological studies needed to assess adverse effects from the contaminants of concern on receptor species. Initial designing for the Task 9 ecotoxicological field investigations will begin after contaminants of concern and key receptor species have been selected in Task 2. Species to be sampled for tissue analyses will be designated to the earliest extent possible in order to avoid a duplication of the Task 3 sampling effort.

The need for measuring additional ecotoxicological endpoints in Task 9 will be evaluated based on the pathways analyses and published information on direct toxic effects. Selection of field methodologies will be based on a review of available scientific literature providing quantitative data for the species of concern or similar test species. Analysis of population, habitat, or ecosystem changes will be based on species or habitats that represent broad components of the ecosystem or are especially sensitive to the contaminants. In order to select methodologies for the ecotoxicological field sampling program, the biological response under consideration and the proposed methodology should satisfy program DQOs as well as the following more specific criteria:

- The biological response is a well-defined, easily identifiable, and documented response to the designated contaminant(s) of concern (i.e., methodology and measurement endpoint are appropriate to the exposure pathway)

- Exposure to the contaminant is known to cause the biological response in laboratory experiments or experiments with free-ranging organisms

- Methodology is capable of demonstrating a measurable biological response distinguishable from other environmental factors such as weather or physical site disturbance

- The biological response can be measured using a published standardized laboratory or field testing methodology

- The biological response measurement is practical to perform and produces scientifically valid results (e.g., sample size is large enough to have useful power and small Type II error)

Tissue studies to document site-specific contamination will be conducted in Task 9 for both aquatic and terrestrial systems. Tissue analyses will be conducted on selected species from OU6 and reference areas to document current levels of specific target analytes. Information from the Task 2 data evaluation and Task 3 field survey will determine the species and contaminants to be tested and the methods to be used. Selection of the target analytes, species, and tissues will depend on an initial determination as to which contaminants are likely to adversely impact biota and which contaminants are likely to be present in concentrations sufficient for detection.

Acute and chronic aquatic toxicity tests using fathead minnows and *Ceriodaphnia spp.* are proposed for Task 3 (see Subsection 9.3.5). These simple screening tests will provide an initial determination of the toxicity of potentially complex chemical mixtures in OU6 aquatic ecosystems. If toxicity is observed in either the acute or chronic tests at any one station, then a supplemental toxicity testing program in conjunction with physical and chemical analyses of the water and sediment may be designed for that location to determine the potential extent of the toxicant(s).

Toxicity testing methods are available for terrestrial ecosystems using microbes, earthworms, crickets, and grasshoppers (U.S. EPA 1989e). The need for such tests will be evaluated based on the above criteria as part of this planning process.

Prior to conducting Task 9 studies, the field sampling plan will be refined to address the proposed methodologies. More specific DQOs will be formulated based on the proposed methodologies and will address the following:

- The number and types of analyses to be run
- The species, locations, and tissues to be sampled
- The number of samples to be taken
- The detection limits for contaminants
- The acceptable margin of error in analyzing results

9.2.10 Task 9: Ecotoxicological Field Investigations

Tissue analyses will comprise most of the Task 9 ecotoxicological field investigation. Tissue analyses will be conducted to measure the total concentration of specific chemical compounds in key receptor species. Because individuals and species accumulate contaminants differentially in their tissues depending on the exposure route and form of the contaminants, environmental concentrations and general uptake rates will not necessarily predict biotic concentrations or adverse effects. Analysis of tissue contaminant concentrations will provide data to evaluate the predicted relationship, if any, between environmental concentrations and the amount of contaminants accumulated in receptor species. Selection of the species and specific tissues for analysis will be based on a preliminary evaluation of site-specific food webs, potential contaminant transport pathways, and the potential for bioaccumulation, bioconcentration, and biomagnification. Whole bodies or specific tissues will be analyzed depending on which portion is consumed by higher trophic level organisms. Suitability of the species for sampling and sampling size requirements will largely determine the species to be selected for tissue analysis.

To the extent possible, tissue samples will be collected simultaneously with environmental media samples. This will allow for a determination of site-specific BCFs. These BCFs will be incorporated into the final exposure assessment and will be used to calibrate/validate the pathways model. Where BCFs cannot be determined, published or predicted BCF values will be used in the pathways model to assess potential impacts.

Statistical tests will be used in the measurement of the contaminant-specific biological response in samples from OU6 and the reference areas. Use of statistical tests will be consistent with DQOs and quality assurance provisions of the Quality Assurance Project Plan (QAPjP).

Additional ecotoxicological studies or toxicity tests may include in-situ (in-field) and/or laboratory toxicity tests. In-situ methods usually involve exposing animals in the field to existing aquatic or soil conditions. Laboratory toxicity tests can be used to evaluate the lethal or sublethal effects of chemicals as they occur in environmental media. Both approaches can be used to test for toxicity of mixtures as they actually occur in the environment. Selection of a particular methodology is generally based on the capability of the method to demonstrate a measurable biological response to the selected contaminant(s) of concern in addition to those specific criteria presented in Subsection 9.2.9.

9.2.11 Task 10: Environmental Evaluation Report

Task 10 will include the summary of information and production of an Environmental Evaluation Report as part of the RFI/RI Report. The Environmental Evaluation Report will be prepared in a clear and concise manner to present study results and interpretation. All relevant data from the environmental evaluation, in addition to relevant Phase I RFI/RI data, will be integrated and evaluated in the characterization of potential environmental impacts. The following topics will be covered in the report:

- Objectives
- Scope of Investigation
- Site Description

- Contaminants of Concern and Key Receptor Species
- Contaminant Sources and Releases
- Exposure Characterization
- Impact Characterization
- Remediation Criteria
- Conclusions and Limitations

A proposed, detailed outline of the report is shown in following Table 9-6.

Remediation Criteria

Remediation criteria protective of site-specific plants and animals for the contaminants of concern can be developed in Task 10 based on ecological effects criteria and detailed food-web analyses using a calibrated/validated pathways model. Ecological effects criteria are determined by tracing the biomagnification of contaminant residues from organisms at the top of the food web back through intermediate trophic levels to the abiotic environment. The "no effects" criteria levels for abiotic media are then derived from contaminant concentrations known to produce sublethal effects in the most sensitive (usually highest trophic level) organisms. Development of ecological effects criteria for OU6 will be based on results of the pathways model as well as available data which document potential adverse effects from contaminants of concern on key biological receptors. The process for establishing ecological criteria is shown in Figure 9-2. Determination of these criteria for OU6 will be coordinated with other RFI/RI studies and environmental evaluations.

The acceptable (no-effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects on biota as appropriate for the environmental evaluation portion of the Phase I RFI/RI. This approach will be integrated with the Human Health Risk Assessment process and will assist in the development of potential remediation criteria.

9.3 FIELD SAMPLING PLAN

The OU6 Environmental Evaluation is planned in 10 tasks as described in Subsection 9.2. Field sampling activities will be conducted in Task 3 and Task 9 of the environmental evaluation. Task 3 will include brief field surveys, an ecological inventory of biota present at OU6, and initial aquatic toxicity testing. The field surveys and inventory will be conducted to obtain information on the occurrence, distribution, and general abundance of biota in OU6. Data obtained in the field inventory will be used to identify key receptor species, to develop a site-specific food web model and to provide input to the pathways analysis and contamination assessment. Planning for the Task 9 tissue analysis program will begin in Task 2 so that samples collected in the Task 3 field inventory may be used wherever possible (i.e., where contaminants of concern have been defined and field sampling protocol have been

TABLE 9-6
PROPOSED ENVIRONMENTAL EVALUATION REPORT OUTLINE
WALNUT CREEK DRAINAGE

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 OBJECTIVES
1.2 SITE HISTORY
1.3 SCOPE OF EVALUATION

2.0 SITE DESCRIPTION

2.1 PHYSICAL ENVIRONMENT

2.1.1 Air Quality/Meteorology
2.1.2 Soils
2.1.3 Surface Water
2.1.4 Groundwater

2.2 BIOTIC COMMUNITY

2.2.1 Freshwater Community
2.2.2 Terrestrial Community
2.2.3 Protected/Important Species and Habitats

3.0 CONTAMINANT SOURCES AND RELEASES

3.1 SOURCES
3.2 RELEASES

4.0 CONTAMINANTS OF CONCERN

4.1 CRITERIA DEVELOPMENT FOR SELECTION OF CONTAMINANTS OF CONCERN
4.2 DEFINITION OF CONTAMINANTS

5.0 TOXICITY ASSESSMENT

5.1 TOXICITY ASSESSMENTS OF CONTAMINANTS OF CONCERN
5.2 CONTAMINANT EFFECTS

5.2.1 Terrestrial Ecosystems
5.2.2 Aquatic Ecosystems

6.0 EXPOSURE ASSESSMENT

6.1 CONTAMINANT PATHWAYS AND ACCEPTABLE CRITERIA DEVELOPMENT

6.1.1 General Methodology for Pathway Analysis
6.1.2 Selection of Key Receptor Species

6.2 EXPOSURE POINT IDENTIFICATION

6.2.1 Soil

TABLE 9-6
(Concluded)

6.2.2 Water
6.2.3 Vegetation

6.3 CHEMICAL FATE AND TRANSPORT
6.4 EXPOSURE POINT CONCENTRATIONS

6.4.1 Soil and Sediment Concentrations
6.4.2 Surface Water Concentrations
6.4.3 Groundwater Concentrations
6.4.4 Vegetation Concentrations

6.5 EXPOSURE PATHWAYS

6.5.1 Terrestrial Pathway
6.5.2 Freshwater Pathway

7.0 IMPACT CHARACTERIZATION

7.1 DEVELOPMENT OF ECOLOGICAL EFFECTS CRITERIA

7.1.1 Air Criteria
7.1.2 Soil and Sediment Criteria
7.1.3 Freshwater Criteria
7.1.4 Vegetation Criteria

7.2 EFFECTS CHARACTERIZATION

7.2.1 Terrestrial Pathway

7.2.1.1 Air
7.2.1.2 Soil
7.2.1.3 Vegetation

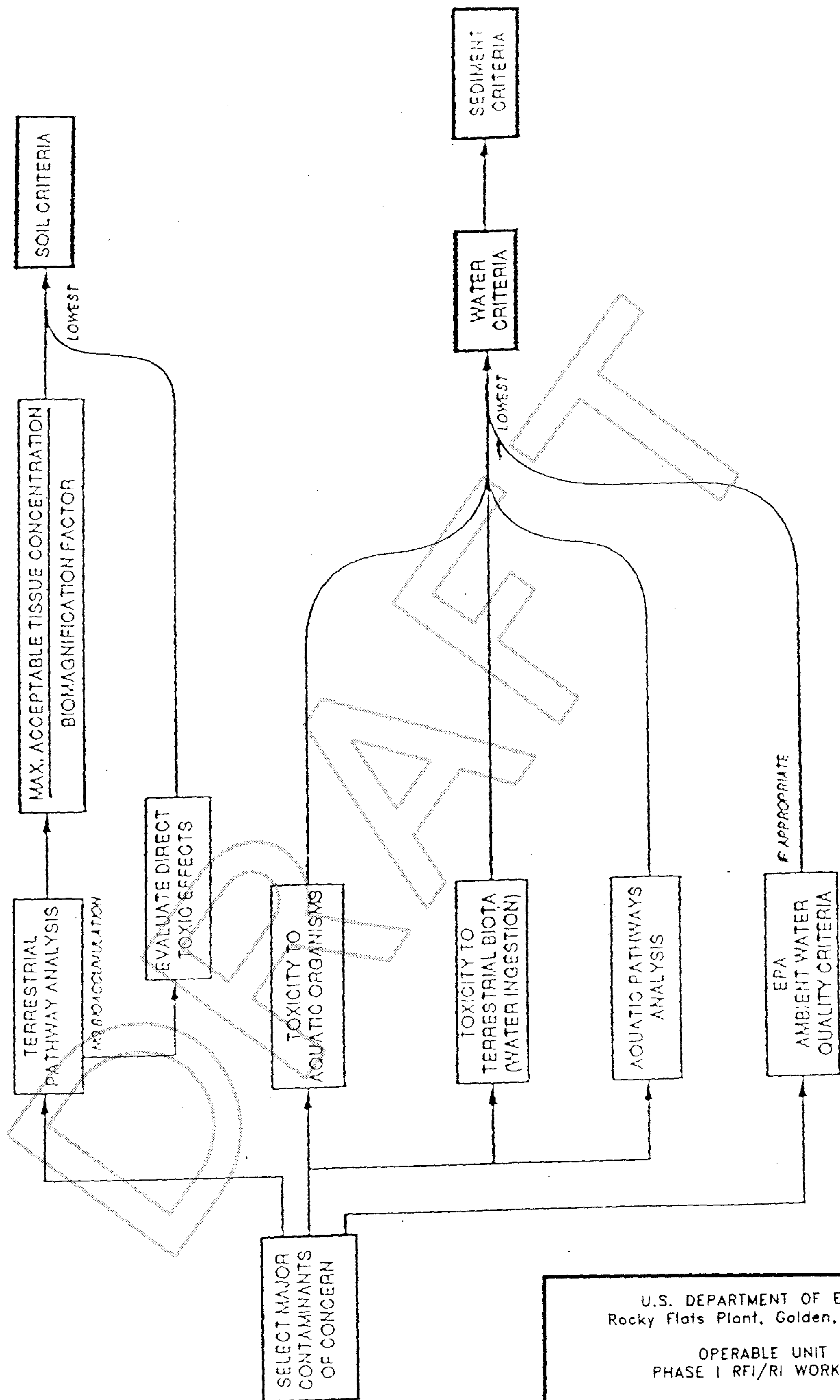
7.2.2 Freshwater Pathway

7.2.2.1 Air
7.2.2.2 Surface Runoff
7.2.2.3 Seeps and Springs

8.0 ASSUMPTIONS AND UNCERTAINTIES

9.0 RECOMMENDATIONS AND CONCLUSIONS

10.0 REFERENCES



SOURCE: REAGAN AND FORDHAM, 1991

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

OUTLINE OF THE METHODOLOGY FOR DETERMINING CRITERIA FOR MAJOR CONTAMINANTS OF CONCERN

FIGURE 9-2 APRIL 1991

developed). Final determination of the need for further ecotoxicological studies (e.g., reproductive success, population studies or enzyme analyses) in Task 9, will be made in Task 8, Planning, after completion of the contamination assessment.

The following field sampling plan is provisional and will be periodically revised as appropriate. The Task 3 sampling plan is largely complete but may be altered in order to better coordinate with the surface water and soil sampling programs for OU6 or other operable units. The Task 9 field sampling plan will be designed in greater detail after contaminants of concern and key receptor species have been identified and a preliminary determination of food webs and contaminant source-receptor pathways has been developed. This information will allow determination as to which contaminants of concern are likely to be present in sufficient concentrations to be detected in biota and which biota are most practical and suitable for sampling.

SOPs for sampling biota as part of the Environmental Evaluation process at Rocky Flats are currently in publication. The SOPs will include discussion of purpose and scope, responsibilities and qualifications, references, equipment, and execution of protocols. Sampling procedures for the following organisms will be included in the forthcoming document:

- Periphyton
- Benthic Macroinvertebrates
- Plankton
- Fishes
- Large Mammals
- Small Mammals
- Birds
- Reptiles and Amphibians
- Terrestrial Arthropods
- Terrestrial Vegetation
- Soil Microbes

SOPs that are currently being developed in addition to the above include the following:

- Design of Field Sampling Plans
- Selection of Reference Areas
- Recording and Managing Data
- Preserving and Handling Samples
- Conducting Laboratory Studies
- Incorporating QA/QC

The preceding SOPS are referenced in the following OU6 Field Sampling Plan where appropriate.

9.3.1 Sampling Objectives

The Task 3 Ecological Field Investigation for OU6 has four broad objectives:

1. Conduct brief field surveys and an ecological inventory to describe the existing ecological setting in terms of habitats, vegetation, wildlife and aquatic species. Conduct initial aquatic toxicity testing using *Ceriodaphnia spp.* and fathead minnows. Observe OU6 for obvious signs or zones of contamination or injury to biota and their habitats. Accomplish an ecological field inventory through the use of established ecological field methodologies (e.g., Mueller-Dombois and Ellenberg 1974; Southwood 1978; Krebs 1989).

2. From the above data, identify key food web species which represent the major flow of energy and nutrients and thus the major pathways for contaminant transfer from physical environmental media to higher trophic-level ecological receptors.

3. Identify the presence or absence of protected or other important species and habitats.

4. Provide site-specific information for determining objectives, measurement endpoints and methodologies for Task 9 field/laboratory contamination studies.

Data from the field survey, inventory and aquatic toxicity tests will be summarized, tabulated and accompanied with a narrative description of the following data types:

- Species Present (Diversity)
- Habitat Descriptions/Mapping Units (Clark et al. 1980)
- Soil Descriptions/Classifications (part of RFI effort)
- Critical/Protected Habitats
- Protected Species
- Terrestrial and Aquatic Food Webs
- Potential Exposure Pathways
- Abundance of Key Species
- Vegetation Cover and Biomass
- Vegetation Frequency and Density (shrubs/trees)
- Vegetation Importance (community dominance) Values
- Aquatic Toxicity Test Results

Appropriate statistical tests will be used to analyze the data so that precision and accuracy of the results can be presented at a stated level of confidence. Depending on the data types being analyzed, within-and-between station differences, within-and-between season differences, and within-and-between species differences will be presented. Means, variances, standard errors, analyses of variance, regression, and correlation coefficients will be computed as appropriate. Where sample sizes are insufficient to detect differences, only descriptive statistics will be prepared.

9.3.2 Sample Location and Frequency

Both Task 3 and Task 9 field sampling activities for OU6 will be located and timed to the extent possible to coincide with collection of other media samples (soils, surface water, and groundwater) as well as sampling activities at other operable units. This integrated sampling approach is consistent with EPA guidance and will provide a synoptic view of potential contaminants in all relevant media at one time.

The field sampling plan for Task 3 is based on the assumption that brief field surveys will be conducted in the spring, summer, fall, and winter and that the ecological field sampling program will take place within the May-June and July-August timeframes. Aquatic toxicity testing will take place in May-June (high flow) and September-October (low flow). Information from the initial surveys and field inventory may be used to modify sampling parameters for later field investigations.

9.3.2.1 Locations for Vegetative Sampling

Vegetation sampling for phytosociological data will be performed at each of the OU6 IHSSs, and along the unnamed Tributary and North and South Walnut Creek. A systematic walk-through of these areas will be conducted in the spring, summer, and fall to observe species composition.

A stratified randomization procedure will be utilized to identify sampling locations for the quantitative vegetative description portion of the field inventory. The basis for selecting a random procedure of vegetation transect/plot location is to obtain as unbiased an estimator as possible of true population parameters for herbaceous cover and biomass, and shrub/tree density and frequency. Stratification is required because several distinct vegetation types appear to be present in the study area, including prairie grassland, marsh, streambank vegetation, well-vegetated disturbed areas, and sparsely vegetated disturbed areas.

The basis for stratification will be a vegetation type map, to be prepared based on the 1975 University of Colorado vegetation map of Rocky Flats and the Clark et al. (1980) report, updated by visual observations during the field surveys. This map will cover the OU6 drainage.

Transects for the quantitative community surveys will be located near soil sampling sites (see Subsection 7.2) wherever possible. From each soil sampling point, the centerpoint of a vegetation transect will be selected based on a random distance (to 10 m) and random direction, using random numbers tables. Transect locations will be selected until an adequate number have been selected for each major vegetation type at each IHSS. Locations will be discarded under several conditions: where the selected location is in a vegetation type for which an adequate number of transects has already been selected (for each IHSS); where the vegetation is not homogeneous (i.e., located in more than one type or across an ecotone); and where the transect would be located in buildings or paved areas. A similar process will be used for transects along the Unnamed Tributary, and North and South Walnut Creek, where sample locations will be located in the general area of surface-water/sediment sampling points. Since vegetation types associated with these features tend to be linear, the randomization process may require limits on direction. Multiple transects will be located near (within 50 meters of) each surface water/sediment sampling point to provide an adequate sample size.

9.3.2.2 Locations for Periphyton, Macrobenthos and Fish Sampling

Periphyton, macrobenthos and fish samples will be collected at the following existing surface water and sediment sampling locations: SW-96, SW-100, SW-110, SW-111, SW-16, SW-24, SW-25, SW-03 and the four A-Series and five B-Series Ponds (Figure 9-3). Should the organisms or proper habitat be absent at a particular location, then the nearest location downstream with suitable habitat will be sampled and located on a map. Sampling at the OU6 sites will be coordinated with OU6 surface water and sediment sampling activities as well as with other operable unit sampling programs. Both surface water and sediment data should be collected at the same locations as the aquatic biota sampling locations. Sampling locations may be altered to assure these efforts are coordinated. Sampling locations for aquatic biota may also be altered depending on DQOs, required sample size, or aquatic habitat requirements for sampling.

9.3.2.3 Locations for Wildlife Sampling

A terrestrial wildlife inventory will be conducted within the North and South Walnut Creek and Unnamed Tributary Drainages. Small mammal sampling will be conducted, to the extent possible, at the vegetative sampling locations. Searches for reptiles will be conducted in the appropriate habitats within OU6.

9.3.2.4 Locations for Initial Toxicity Testing

Locations for initial aquatic toxicity testing will be mostly the same as those for periphyton, macrobenthos and fish sampling: SW-96, SW-100, SW-110, SW-111, SW-16, SW-24, SW-25, SW-03 and the four A-Series and five B-Series Ponds (Figure 9-3). Toxicity testing activities for OU6 will be coordinated with toxicity testing activities proposed for other operable units and the current toxicity testing program at Pond B-3.

9.3.2.5 Tissue Sampling Locations

Locations for the collection of tissue samples (terrestrial vegetation, periphyton, benthos, macrobenthos, fish) will be the same as those for terrestrial and aquatic sampling. An initial identification of species for tissue sampling will be made in Task 2. Additional sampling requirements will be determined during the contamination assessment (Tasks 4 through 7) and contaminant data from surface water, soil and sediment sampling. The intent is to collect tissue samples where existing abiotic media sampling has indicated significant contamination to occur. Development of the OU6 tissue sampling program will be coordinated with tissue sampling activities at other nearby operable units.

9.3.2.6 Sample Frequency

Brief field surveys will be conducted during 1-week periods in the spring, summer, fall, and winter. Special note of transitory species, migratory species, and seasonal breeding habits will be made during these multi-season surveys.

Field inventory sampling will occur during the May-June and July-August timeframes. Samples collected during the inventory will be saved and used in the tissue analysis studies where sampling and analysis protocol have been established.

Initial toxicity tests will also be conducted during May-June (high flow) and September-October (low flow). Two acute and two chronic tests will be conducted within 1 to 2 weeks of each other during each season. If toxicity is observed in either acute or chronic tests at any one station, then a supplemental program will be designed for that location to determine if the toxicity is consistent and to determine the potential extent of the toxicant.

9.3.3 Reference Areas

Tissue analysis studies may require the sampling of contaminated and control areas in order to establish a relationship between contaminated conditions and background conditions in areas not exposed to RFP contamination. Selection of reference areas may be based on criteria developed in the Task 1 preliminary planning process and may be coordinated with similar efforts at other operable units. Potential selection criteria include species to be sampled and similarity to OU6 in terms of topography, aspect, soils, vegetation, range type and land use history. Reference areas will be upwind from prevailing air flow patterns through RFP and upstream from drainage off RFP.

SOPs for sampling biota as part of the Environmental Evaluation process at Rocky Flats are currently in publication. Additional aquatic reference areas ideally should be located in Rock Creek. A site visit will be made of the proposed aquatic sampling locations for OU6. Habitat characteristics will be noted if not previously recorded in ongoing RFP studies (depth, flow, substrate type, pool/riffle, aquatic/streamside vegetation, etc.). This process will be repeated at potential reference sites. The reference site locations will be based on Task 1 criteria, DQOs, and the selected assessment/measurement endpoints.

9.3.4 Field Survey and Inventory Sampling Methods

Sampling methods for periphyton, benthic macroinvertebrates, fishes, mammals, birds, reptiles and amphibians, terrestrial arthropods, and terrestrial vegetation are detailed in the Ecology SOPs. The SOPs include several standardized forms to be used when sampling biota. Site Description Form 5.0D will be used for sampling terrestrial biota; stream and pond habitat description forms (Forms 5.0A and 5.0B) will be completed at each of the aquatic sampling locations. Chain-of-custody field sample forms will be completed where samples are collected for laboratory analysis or voucher specimens. Additional forms to be completed are specified in the following subsections.

9.3.4.1 <u>Vegetation</u>

Both qualitative and quantitative methods will be used to characterize the terrestrial and wetland vegetation at OU6. Qualitative surveys using a relevé analysis will be conducted in the spring, summer, and fall to record the floristic composition of the plant communities present. These surveys will include a systematic walk-through of OU6. The following data will be recorded on all vegetation species encountered:

- Scientific name
- Common name
- Life form
- Vegetative stage at the time
- Qualitative statement on condition
- Qualitative statement on abundance (relevé analysis - see Ecology SOPs)

Quantitative procedures will be used to collect structural and compositional data. Point-intercept transects will be used to collect data on species cover. Data will be recorded on Form 5.10B, point-intercept data form. Belt transects will be used in conjunction with the point-intercept transects to collect data on shrub cover and density. Trunk diameter, height, canopy diameter, and species will be recorded for any trees within the belt transect or within any IHSS. Shrub and tree data will be recorded on Form 5.10C, belt transect data form. Production data (standing biomass) will be collected from 1/4-

to 1-m^2 quadrants at the same locations as the transects. Different quadrant sizes may be used depending on vegetation type (e.g., a 1/4-m^2 quadrant may be used on dense streambank vegetation). Production data will be recorded on Form 5.10D.

Each plot or 10-meter length of transect will be considered as an observation in calculating the mean and variance. Sample adequacy will be determined for total herbaceous cover/total fresh weight biomass using Cochran's formula (1977):

$$N = \frac{(t^2)(s^2)}{[(x)(d)]^2}$$

where: N = the minimum number of samples needed

- t = t distribution value for a given level of confidence
- s^2 = the variance estimate
- x = the mean of the sample
- d = the level of accuracy desired

9.3.4.2 Terrestrial Wildlife and Invertebrates

The Task 3 survey is planned to note the presence or absence of terrestrial/wetland species and to make note of their food habits. The survey procedure will include a systematic walk-through of Walnut Creek Drainage to record ecological features. Field data will be recorded on the standardized qualitative survey/relative abundance data form 5.0C for large mammals, small mammals, birds, reptiles and amphibians, and terrestrial arthropods. Opportunistic observations of bird and raptor nests, large mammal pellets and mammal burrow/dens will be recorded on the appropriate forms. Vocalization surveys for birds and anurans will also use the appropriate forms. Data to be recorded include:

- Species encountered/ observed
- Scientific name
- Common name
- Qualitative statement on:
  - Condition
  - Abundance
  - Habitat requirements
  - Predator/prey species/food habits
  - Regulatory status (to be determined prior to field sampling)

- Species presence will be determined by:

  - Visual observation
  - Vocalization
  - Burrow/den
  - Nest
  - Droppings/scat

Quantitative information on wildlife populations will be obtained in the Task 3 field inventory. Inventory sampling will include the following procedures which are detailed in the SOPs:

- Live trapping of small mammals at each IHSS and along the drainages. Data to be recorded include:

  - Scientific name/common name
  - Sex
  - Reproductive condition
  - Weight
  - Life history stage

- Reptile occurrence will be recorded along the same transects used for small mammal trapping in addition to habitat searches. Data to be recorded include:

  - Species encountered
  - Activity
  - Habitat
  - Qualitative statement on abundance

- Medium- and larger-sized mammals will be counted by recording all species along a systematic walk-through of OU6. The counting will occur during the small mammal transect trapping. Species encountered and activity will be recorded.

- Foliage invertebrates will be collected by sweep net and beating. Where conditions permit, foliage invertebrate and arthropod sampling may be conducted using a D-vac suction sampler in place of sweep netting. Data to be recorded will include:

- Host plant
- Herbivore
- Position in food web

9.3.4.3 Periphyton

Sampling to characterize periphyton communities will occur at the selected locations along the Unnamed Tributary, North and South Walnut Creek, and the A- and B-Series Ponds. Data to be collected include:

- Scientific name
- Algal density (cell counts)
- Biomass (chlorophyll-a and phaeophytin-a concentrations)

Methodologies for sampling periphyton for the above parameters are detailed in the SOPs. Field data will be recorded on the periphyton field sample form 5.1A (see SOP). Data from quantitative sampling will be used to determine species diversity and standing crop (biomass). All analyses will be completed within five days of the collection of the slides from the field (U.S. EPA 1987b).

9.3.4.4 Macrobenthos

Benthic invertebrates are the most common fauna used in ecological assessments of contaminant releases and are defined as the invertebrates retained by screens of mesh size greater than 0.2 mm. Macrobenthos will be sampled at the aquatic sampling locations shown in Figure 9-3 using the procedures described in the SOPs. Triplicate samples will be taken on a transect upstream and within 10 meters of the designated sampling locations. Data to be collected include:

- Scientific name (generally to genus)
- Number of individuals in each taxon

Field data will be recorded on the benthic macroinvertebrate field sample Form 5.2A. Data from quantitative samples will be used to determine macroinvertebrate density (standing crop), taxa richness, species diversity and ratio of pollution-tolerant and pollution-sensitive taxa.

9.3.4.5 Fish

Fish will be collected in 10- to 25-meter-long collection areas using a backpack shocker or by seining blocked-off creek sections. In the A- and B-series Ponds, fish will be sampled from a flat-bottom boat using an electroshocker. Data to be collected include:

- Scientific name
- Number of individuals in each taxon
- Length
- Weight

Scales will be collected to obtain data on age classes versus size, population structure and survivorship. Field data will be recorded on the fish field inventory form 5.4B (see SOP). Samples will be taken for laboratory identification/confirmation. Analyses will consist of compiling and summarizing the number, size, and weight of each species of fish captured at each sampling site. Graphic presentations may include fish length-frequency histograms and plots of catch per effort for each sampling area.

9.3.5 Initial Toxicity Tests

The initial toxicity testing program will be limited to aquatic organisms and will include standardized EPA acute and chronic tests with fathead minnows and *Ceriodaphnia spp.*. Water samples will be cooled to 4°C and shipped to the laboratory conducting the toxicity tests within 12 to 24 hours. The toxicity tests will be initiated within 36 hours of the field collection time. The duration of the static renewal acute tests will be 48 hours for Ceriodaphnia and 96 hours for fathead minnows. The test water will be renewed daily using dilution water from the sampling station. The static renewal chronic tests will last for 7 days for fathead minnows and until 60 percent of the Ceriodaphnia in the control vessels have three broods. Quality control procedures will conform to the EPA requirements for NPDES toxicity testing currently being used at Rocky Flats and to the QAPjP.

9.3.6 Tissue Analysis Sampling Methods

The methodologies selected for tissue analysis studies will depend on the contaminants of concern and their anticipated effects on key receptor species. Contaminants of concern and key receptor species will be determined as early as possible in Task 2. It is anticipated that some biota samples collected in the Task 3 field inventory can be used for tissue analysis. Standardized site protocol for preserving samples for tissue analyses will be followed in those instances where it is anticipated that tissue analyses will be conducted.

Analyses for metals and radionuclides in biota may call for a greater biomass of tissue than is available through standard collection methods. At least 80 grams of material (wet weight) is needed per sample for metals analysis, and 100 grams of material (dried and ashed) is needed for radionuclides. Obtaining this amount of sample may be impractical for some species of vegetation, periphyton, benthos, and macrobenthos. It is also not the intent of the sampling program to cause unnecessary disturbance or damage to the biota communities in order to collect sufficient samples. Sampling design will be adequate to ensure statistically valid results. DQOs for the tissue sampling program will be evaluated with respect to this determination prior to field collection activities.

Based on the literature reviewed and the information presented in this report, it is anticipated that most tissue samples will be analyzed for metals and some organic compounds (e.g. polycyclic aromatic hydrocarbons); few samples, if any, may be analyzed for radionuclides. Tissue samples collected for contaminant analysis will be sent to a laboratory for specific metals and radionuclide analyses as determined in the preliminary Task 1/Task 2 environmental evaluation. Analytical methods will follow SOPs.

Holding times, preservation methods, sample containers, and field and laboratory quality control sample numbers are contained in the Quality Assurance Project Plan (QAPjP) and shown in Table 9-7. Tissue sampling protocol for biota are not necessarily standardized and may vary depending upon the laboratory conducting the analyses. Specific sample preparation requirements will be reported in SOPs which are currently in development.

9.3.7 Sampling Equipment

Equipment for field sampling of biota are identified in the Volume V Ecology SOPs.

9.4 SCHEDULE

Figure 9-4 presents a proposed schedule for implementation of the OU6 environmental evaluation. The schedule follows the task approach presented in this environmental evaluation. While many of the tasks are sequential, most tasks will overlap in time. The months indicated in the table reflect the timeframe in which the activity will occur and not necessarily the amount of time necessary to complete the task. The schedule is provisional and likely to change depending on the Phase I OU6 RFI/RI activity schedule as well as schedules from other operable units.

TABLE 9-7

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size++
SAMPLES FOR METALS ANALYSES				
TERRESTRIAL VEGETATION				
- Metals Determined by ICP**	6 mos	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Metals Determined by GFAA+	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	5 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Metals Determined by ICP	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Metals Determined by GFAA	6 mos	Freeze & ship w/dry ice	Plastic	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Plastic	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Plastic	5 g

TABLE 9-7
(Concluded)

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size++
SAMPLES FOR RADIONUCLIDE ANALYSES				
Terrestrial Vegetation				
- Uranium-233, 234, 235, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	100 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Uranium-233, 234, 245, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/dry ice	Plastic	100 g

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

+GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pg, Se, and Sr.

++ Sample size may vary with specific laboratory requirements.

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10.0
QUALITY ASSURANCE ADDENDUM

The Quality Assurance Addendum [QAA] QAA 6.1 to the Rocky Flats site-wide QA Project Plan has been prepared for OU6 Walnut Creek Drainage (EG&G 1991e).

The following Rocky Flats Plant (RFP) program-wide Standard Operating Procedures (SOPs) will be utilized during the specific field investigations for Operable Unit Number 6 (OU6).

1.13	Containerizing, Preserving, Handling and Shipping Soil and Water Samples
1.14	Data Base Management
1.16	Field Radiological Measurements
2.1	Water Level Measurements in Wells and Piezometers
2.2	Well Development
2.5	Measurement for Groundwater Field Parameters
2.6	Groundwater Sampling
3.1	Logging Alluvial and Bedrock Material
3.2	Drilling and Sampling Using Hollow-Stem Auger Techniques
3.6	Monitoring Well and Piezometer Installation
3.8	Surface Soil Sampling
3.9	Soil Gas Sampling and Field Analysis
4.1	Surface Water Data Collection Activities
4.2	Field Measurement of Surface Water Field Parameters
4.3	Surface Water Sampling
4.6	Sediment Sampling
4.8	Pond Sampling

In addition, Field Operations, Volume I, SOPs will also be used as appropriate during field operations.

Specific information concerning sampling activities is provided in the Field Sampling Plan (FSP) (Section 7.0) for most of the sampling activities. Project specific details for this work plan will be included in the Standard Operating Procedures Addenda (SOPAs). These SOPAs will be attached to the SOP for use during field activities.

11.1 SOP ADDENDUM TO SOP NO. 4.6, SEDIMENT SAMPLING

Sediment samples will be collected from five locations each in the A- and B-series Ponds and in IHSS 142.12. In addition, sediment samples will be collected from numerous locations within North and South Walnut Creek. The sediment samples from the ponds will be collected from the following locations:

- The deepest part of the pond
- Within the pond, 5 feet from the pond inlet
- Three locations selected at random within the area of the pond at the time of sampling.

Sediment samples in North and South Walnut Creek will be collected within the channels in locations conducive to the collection of sediments.

The sediment samples at each location will be collected such that they represent the entire vertical column of sediment at the sampling location. Currently the depth of sediment in the detection ponds is unknown. Samples will be collected at 2-foot intervals. All of the sediment samples, except the one from the deepest part of each pond, will be vertical composite samples that represent the entire sediment thickness, up to 2 feet. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. The samples from the deepest part of each pond will be composited at 5-centimeter intervals, instead of 2-foot intervals.

Samples from North and South Walnut Creek will be collected according to SOP No. 4.6, Sediment Sampling. These samples will be collected with a core sampling device capable of obtaining a loggable sample of the entire thickness of sediment at a given location. Samples for analysis of volatile organic compounds (VOCs) will be collected as grab samples and not composited.

Sediment samples from the Detention Ponds will be collected with a King tube sampler with a diameter of not more than 2 inches. Several soil cores may be needed to obtain enough samples for analyses. One of the samples will be maintained in the vertical position and frozen for subsequent geologic logging. This frozen core will be logged according to SOP No. 3.1, with the thickness and character of any thin stratifications in the sediment column noted. The sediment samples collected for chemical analysis will then be composited at 5-centimeter intervals. Sample handling and decontamination procedures will be followed as described in SOP No. 4.6, Sediment Sampling.

11.2 SOP ADDENDUM TO SOP NO. 4.8, POND SAMPLING

Water samples will be collected from five locations each in the A- and B-series Ponds and IHSS 142.12. The specific locations are as follows:

- The deepest part of the pond
- Within 5 feet of the pond inlet
- Within 5 feet of the pond spillway
- Two locations selected at random within the pond

Prior to sampling at each sampling point, profiles of water temperature and dissolved oxygen in the water column will be collected at the sampling location. The Hydrolab Multi-Parameter Measuring Instrument will be used to collect the profiles across the entire water column.

All of the samples except the one from the deepest part of the pond will be vertical composite samples representing the entire depth of the water column at the sampling point. The sampling from the deepest part of the pond will consist of taking grab samples from each of the zones of stratification identified in the water column at that point.

11.2.1 Composited Samples

Following the measurement of temperature and dissolved oxygen at the sampling point, a sample will be collected. The sample may be collected using a regulated flow sampler (described in SOP No. 4.3, Surface Water Sampling), which is pulled through the entire column of water. Samples may also be collected using a peristaltic pump with the intake tubing pulled through the entire water column. VOC samples will be collected as described in SOP No. 4.8, Pond Sampling.

Field parameters such as pH and specific conductance will be measured in the composited sample in accordance with SOP No. 2.5.

11.2.2 Grab Samples

Temperature and dissolved oxygen at the sampling point in the deepest part of the pond will be measured to determine the location of stratified layers at this point. The grab samples will then be collected using a peristaltic pump in each stratified zone for all samples except VOC samples. The uppermost stratified zone will be sampled first, followed by the next lower zone, and so on. The zone at the bottom of the pond will be sampled last. VOC samples will be collected as described in SOP No. 4.8, Pond Sampling.

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APPENDIX A
AS BUILT DRAWINGS FOR PONDS A-2, A-3, A-4

APPENDIX B
AS BUILT DRAWINGS FOR POND B-5

APPENDIX C
INITIAL RADIOMETRIC SOIL SURVEY OF THE TRIANGLE AREA

20-10382-CO-002

October 17, 1974

Mr. W. M. Lamb
Manager, RFAO, USAEC

CARGO CARRIER AREA AND SITE SURVEY

Per your request of October 15, 1974, attached is the following:

1. A description of the instrumentation (Spark V, Fidler and Ludlum) used to survey soil for possible contamination. (Attachment #1)

2. A description of the method being used to survey the cargo carrier area. (Attachment #2)

3. Draft copies of the results to date of the survey of the cargo carrier area. (Attachment #3)

4. A proposed plan to survey the Rocky Flats site. (Attachment #4)

In order for us to carry out all of the surveys proposed in Attachments 2 and 4, additional resources will be required. We presently do not have excess manpower that we could divert full time to these programs.

Also, we have as yet been unable to arrive at reasonable recommendations for the disposition of contaminated soil. The problem is extremely complex as evidenced by the fact that neither the EPA or AEC have been able to arrive at standards for plutonium in soil even after years of study. We will continue to study and review the problems and report to you within 30 days our progress in arriving at recommendations.

M A Thompson
for H. E. Bowman
General Manager

Orig. and 1 cc - Mr. Lamb

cc: M. A. Thompson - Dow, Rocky Flats

REVIEWED FOR CLASSIFICATION/UCNI
By F. J. Curran
Date 2-22-91

ATTACHMENT #1

SOIL SURVEY INSTRUMENTATION

Spark V and Fidler

The Spark V and Fidler are but two of the instruments used to detect fissionable material in the environment. At Rocky Flats, three different types are used. The manufacturers are Eberline, Technical Associates and Nuclear Chicago. The general features of the instruments are shown in Figure 1. All the systems are similar in that a scintillation crystal is used to detect the x-rays and/or low energy gamma-rays from the fissionable material. The detector is coupled to suitable electronics which provide an output reading either by a scaler (Fidler) or a rate meter (Spark). Two types of detectors are used - NaI(Tl) or CaF_2(Eu). They are large diameter (4" or 5") and quite thin ($\sim 1/8$"). They are coupled to a 5" photomultiplier tube. Each instrument is calibrated to record either the 17 keV L-x rays from the fissionable elements or the 60 keV gamma from americium.

The sensitivity above background varies among the instruments but typical sensitivity for the CaF_2 (Eu) detector is 2370 cpm per $\mu Ci/m^2$ for ^{241}Am and 305 cpm per $\mu Ci/m^2$ for ^{239}Pu. This is for the detector 31 cm above an infinite plane source and the analyzer window 22 keV wide centered on 17 keV.

Ludlum 12 (Figure 2)

The Ludlum 12 alpha counter is a portable battery-powered instrument which, when coupled to an air proportional detector (area approximately 100 cm^2), provides the capability of detecting alpha particles having an energy of 4.5 MeV or greater. The count rate is presented as a total count rate on a meter calibrated for 50% geometry. The background for a clean screen and probe is approximately 1 c/m.

The minimum detectable amount is dependent upon the operator's ability to hold the detector at a fixed distance from the surface to be monitored and his ability to control the speed at which the detector is moving. A typical detection limit, given these factors, is 250 c/m for alpha radiation.

ATTACHMENT #3

INITIAL RESULTS OF THE SURVEY OF THE CARGO CONTAINER AREA

Figure 1	Results of the initial Spark V measurements, identification of general areas of known contamination and location of Survey Plots 1 and 2.
Figure 2	Results of soil analysis in areas of known contamination at depths of 0 to 1 inch and 1 to 3 inches.
Figure 3	Layout of Survey Plots 1 and 2 for Spark V survey.
Figure 4	Initial, draft results of Spark V survey of Plot 1.
Figure 5	Initial, draft results of Spark V survey of Plot 2.

Figure 1. Initial Spark V measur

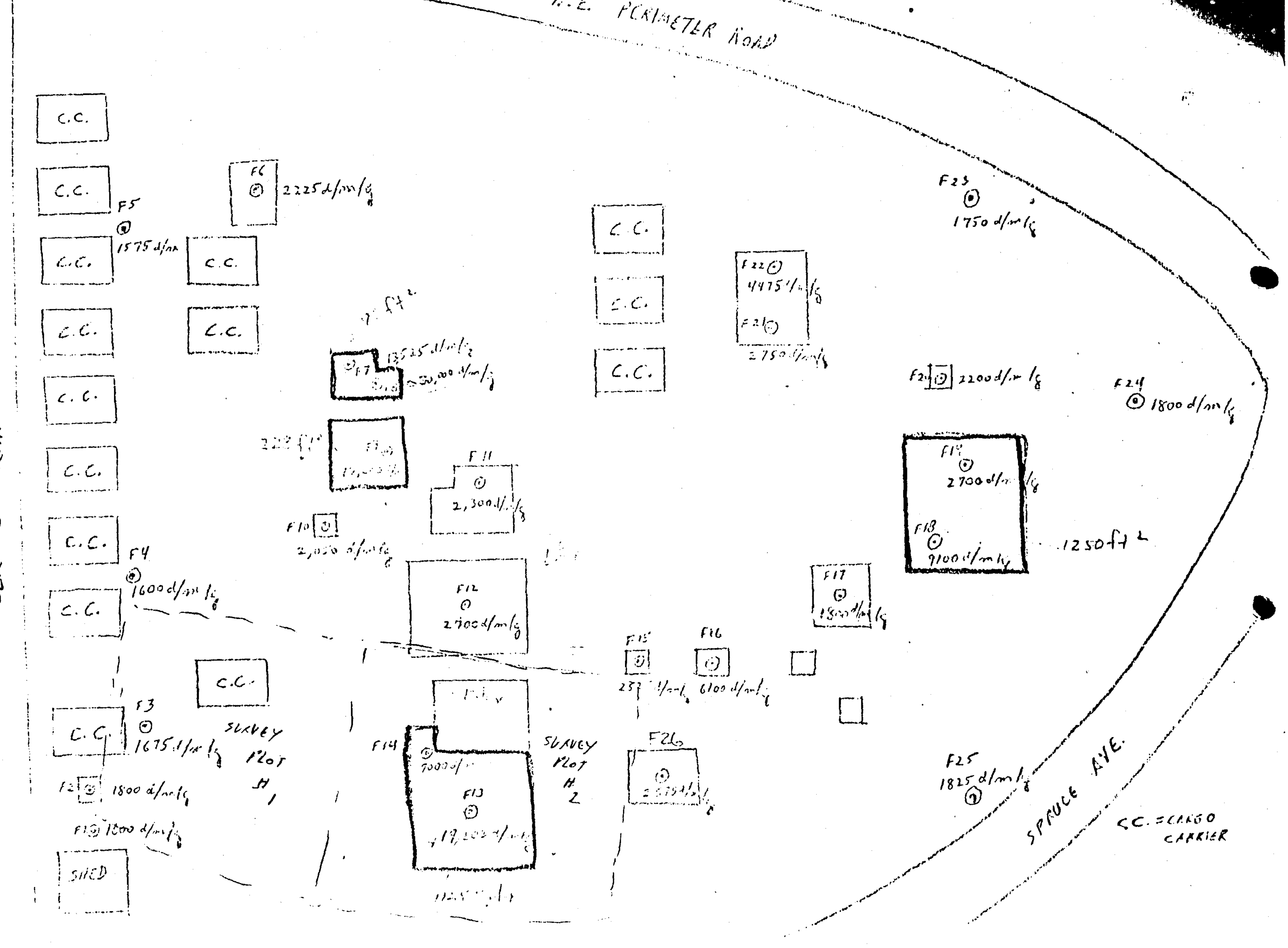


Figure 2. Soil analysis at different depths.

Values in dpm/g sample
$100\ cm^2$ sample area

	0-1		1-3	
	Pu	Am	Pu	Am
F7	4.0×10^4	3.9×10^3	2.8×10^4	6.0×10^3
F8	2.9×10^5	4.5×10^4	2.5×10^4	6.1×10^3
F9	2.3×10^3	4.2×10^2	2.2×10^3	3.6×10^2
F14	5.1×10^2	1.5×10^2	3.2×10^2	5.7×10^1
F13	7.2×10^5	7.0×10^4	2.4×10^5	2.6×10^4

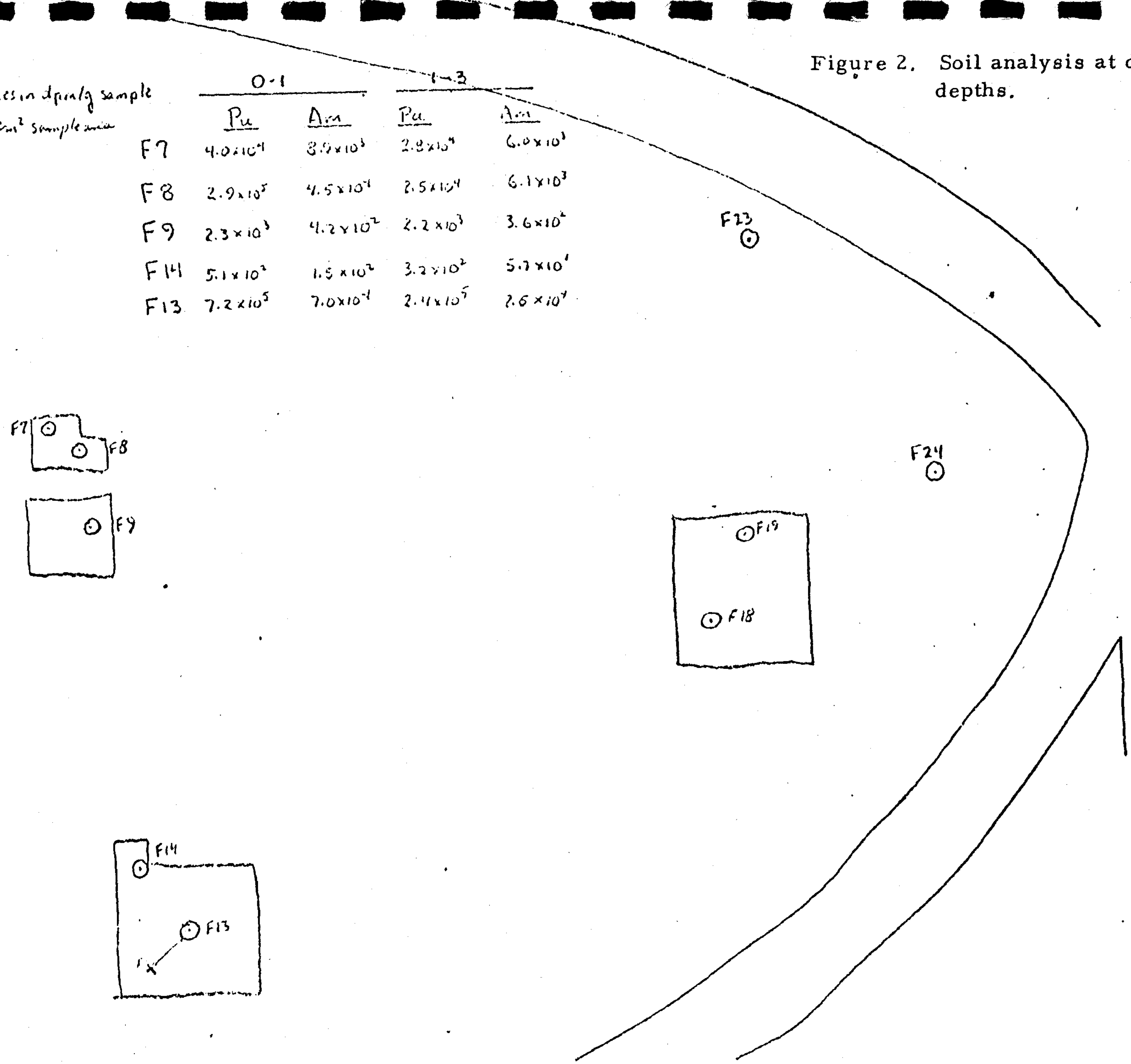
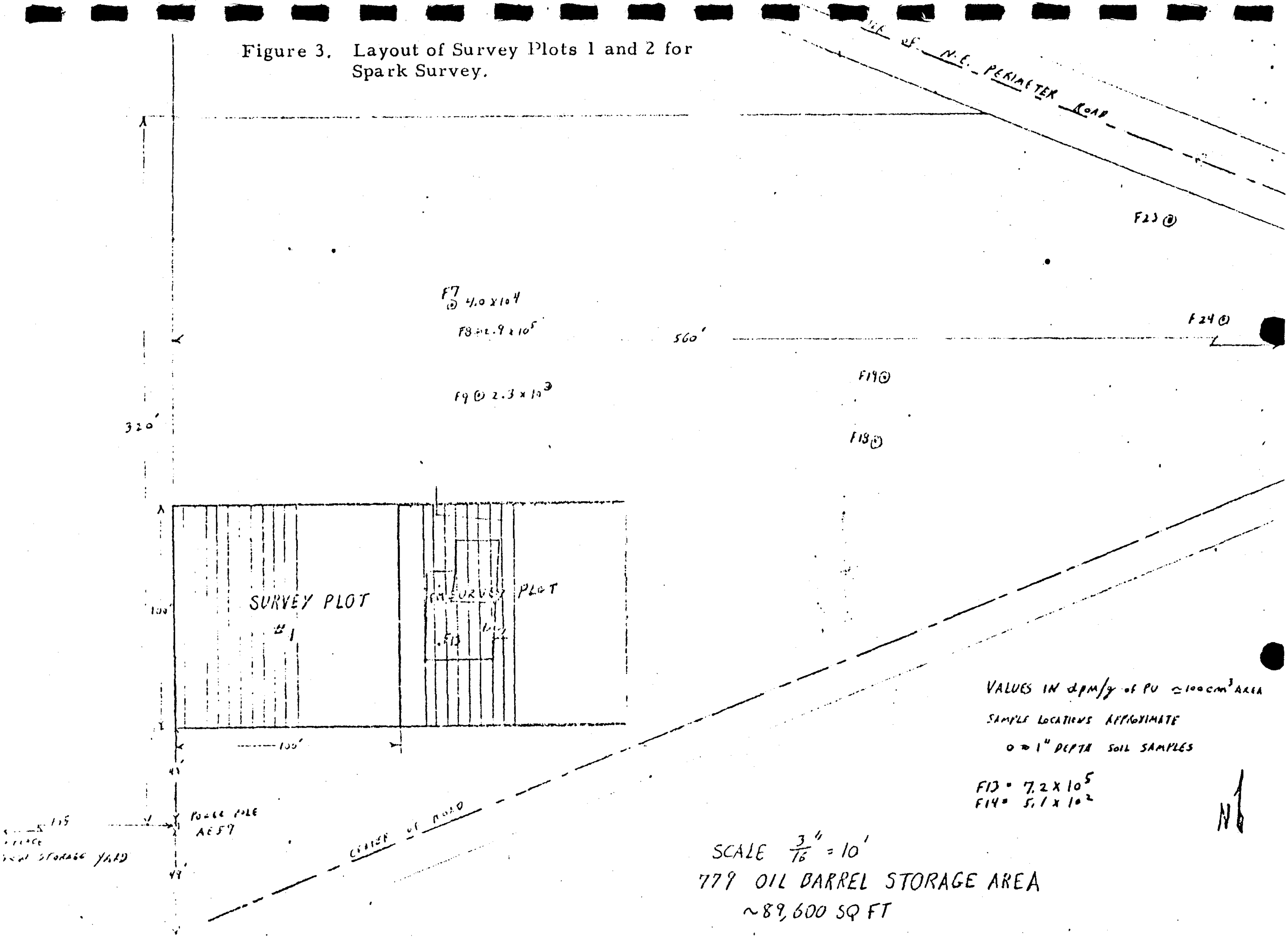


Figure 3. Layout of Survey Plots 1 and 2 for Spark Survey.



SURVEY PLOT # 1

SPARKS

A = 600 c/m

B = 3000

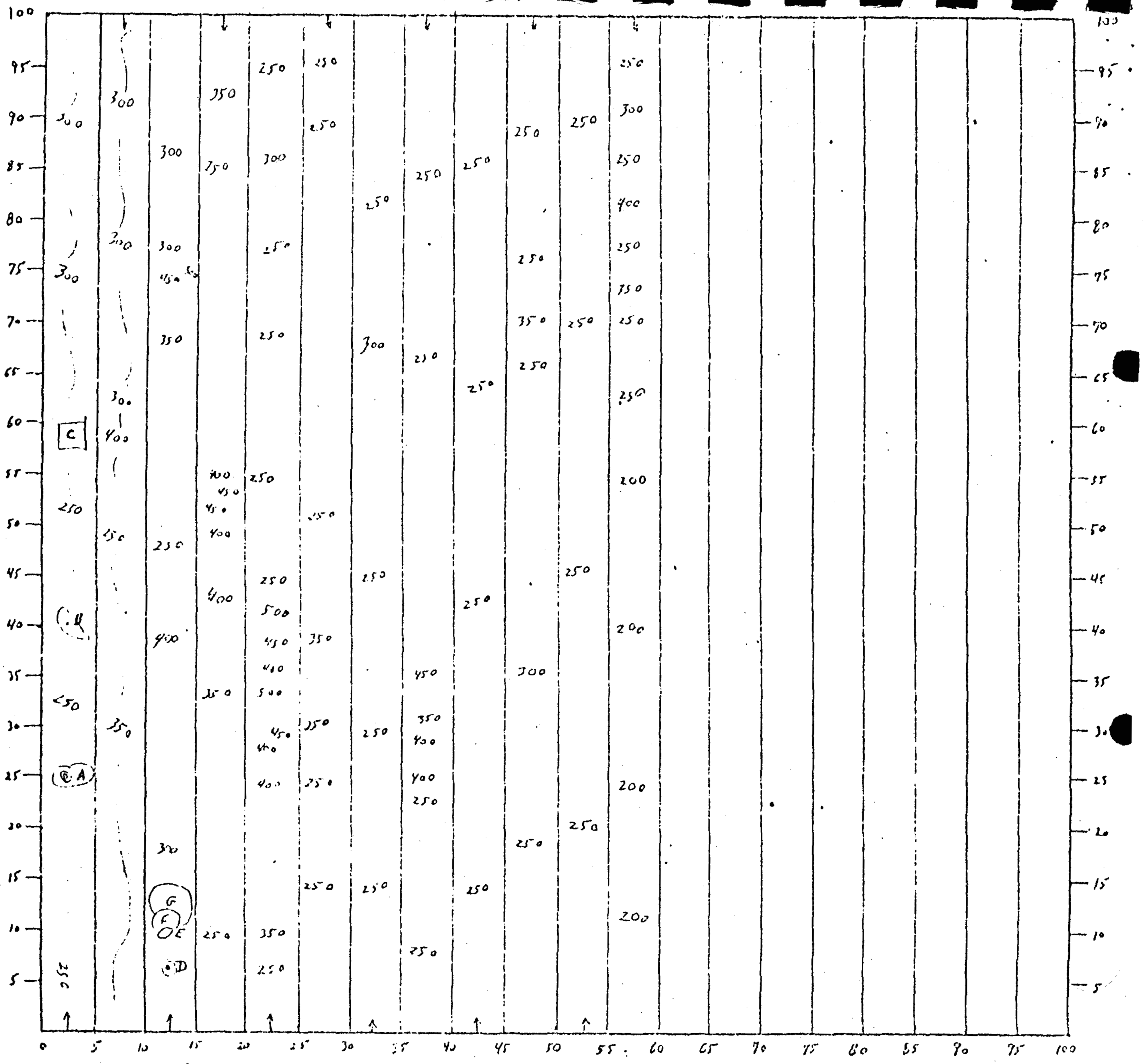
C = 3000

D = 1500

E = 600

F = 1000

G = 2000



$\frac{3''}{4} = 10'$

SURVEY PLOT # 1

SPARK 5

A = 600 c/m

B = 3000

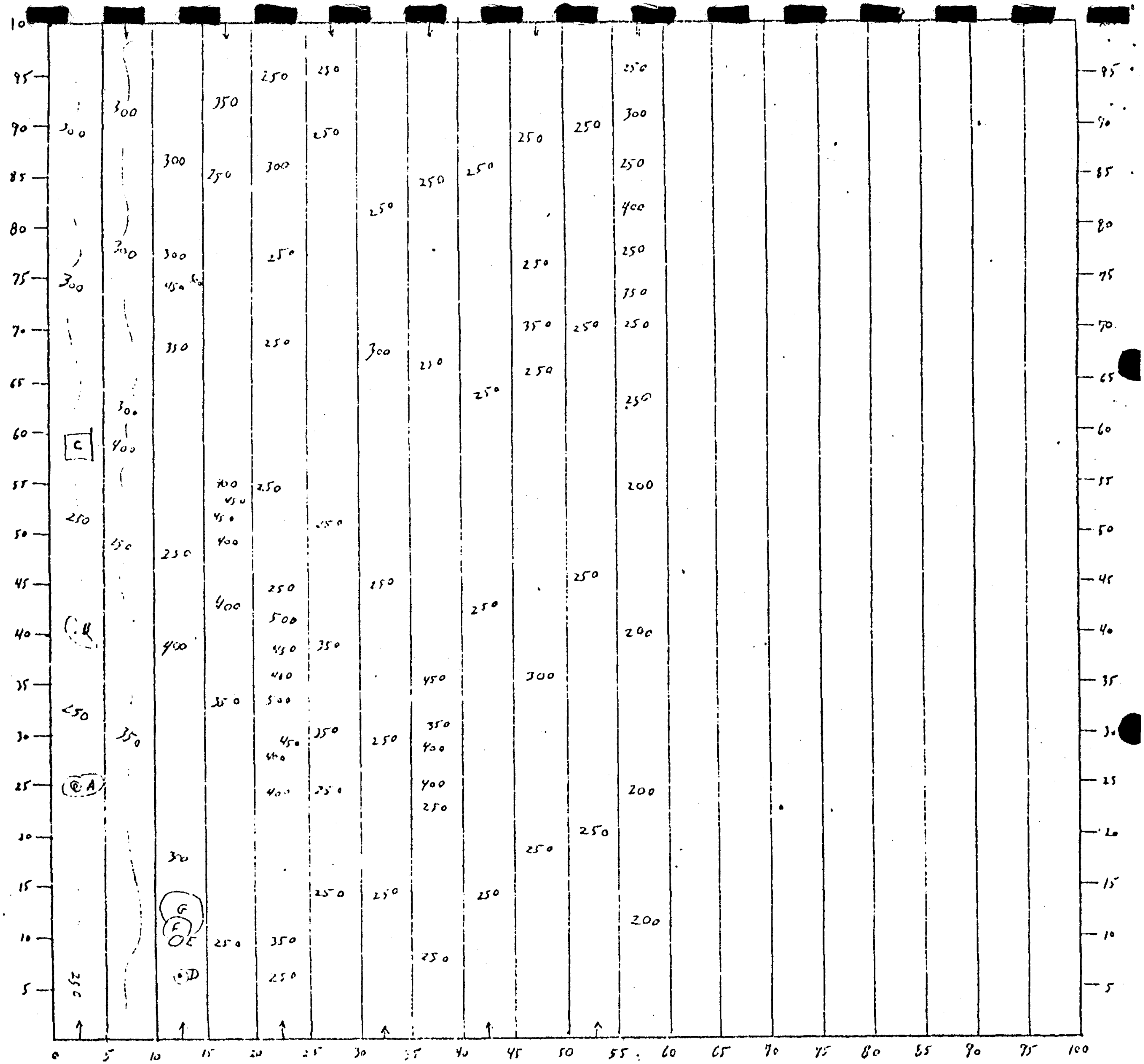
C = 3000

D = 1500

E = 600

F = 1000

G = 2000



$\frac{3}{4}'' = 10'$

10/11/77

Figure 4. Spark V survey of Plot 1

Survey Plot 2

A = 3000

B = 5000

C = 1000

D = 3500

E >500,000 [illegible]

F 50,000

G 3000

H 5000

[illegible]

J [illegible]

[illegible]

L 3500

[illegible]

[illegible]

[illegible]

[illegible] 8500

$\frac{3}{4}'' = 10'$

Figure 5. Sample [illegible] Survey of Plot 2

ATTACHMENT #2

CONTAMINATED SOIL SURVEY IN TRIANGLE AREA (AREA EAST OF EVAPORATION PONDS)

1. Spark Survey

   a. Survey the entire area with a moving probe--a person walking slowly in a progressive pattern on established lines 3 feet apart.

   b. Wooden stake will be placed at appropriate points to identify locations of the pattern.

   c. A map will be drawn of the survey pattern.

   d. Reading above background will be marked on the map.

   e. Reading of concentrated contamination will be staked and identified.

2. Fidler Survey

   a. Areas or points found by the Spark 5 survey to be above background will be measured with the Fidler to attempt to get a quantified figure.

   b. These areas will be gridded on a map.

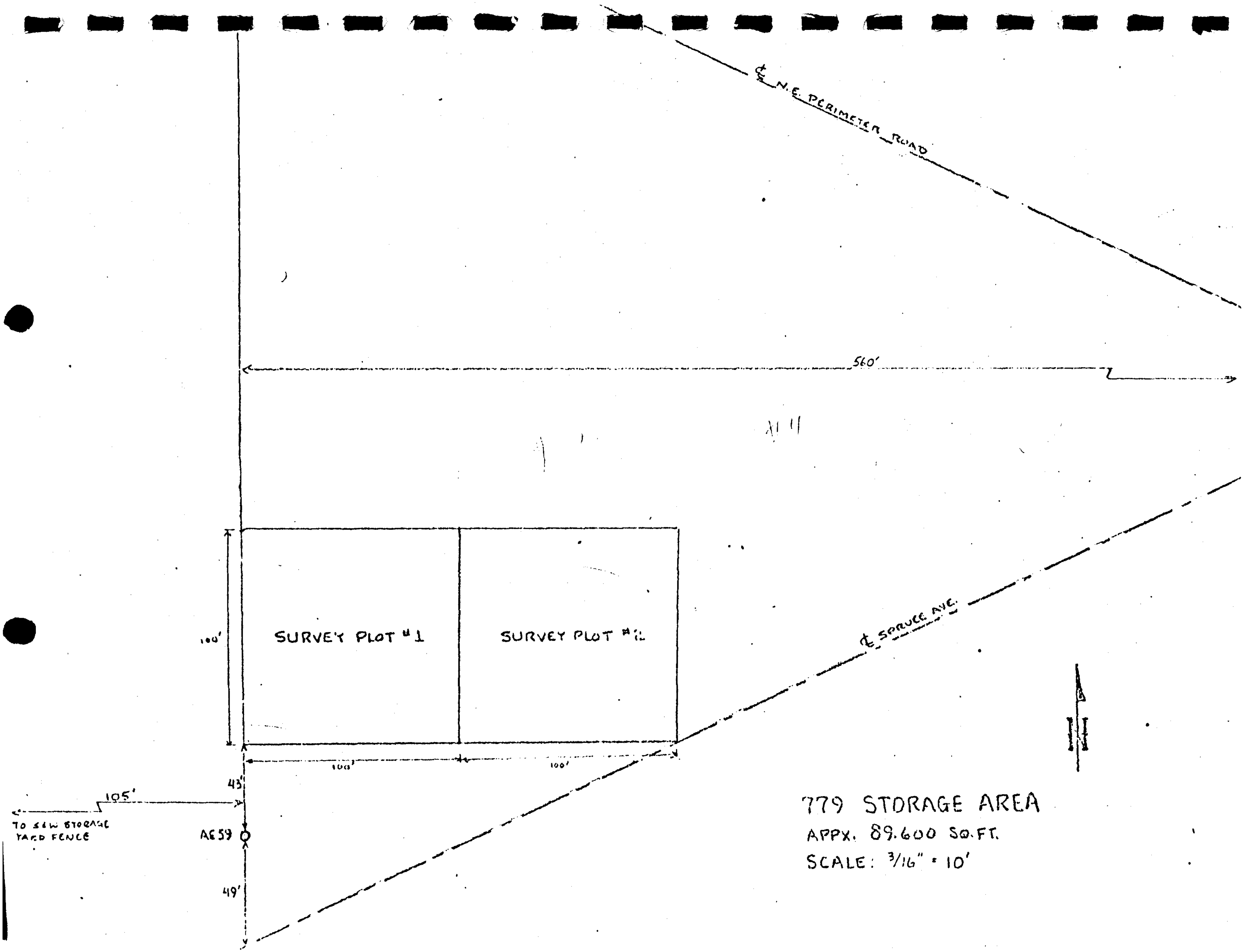
   c. Reading will be taken on 1 foot centers. (Take about 3 minutes each for counting, reading and recording)

   d. Points of concern will be staked and identified.

3. No additional soil samples will be taken.

4. Based on survey results, recommendations will be made as to disposition of soil found to contain levels of contamination above background.

RWH: 10/16/74



779 STORAGE AREA
APPX. 89.600 SQ.FT.
SCALE: 3/16" = 10'

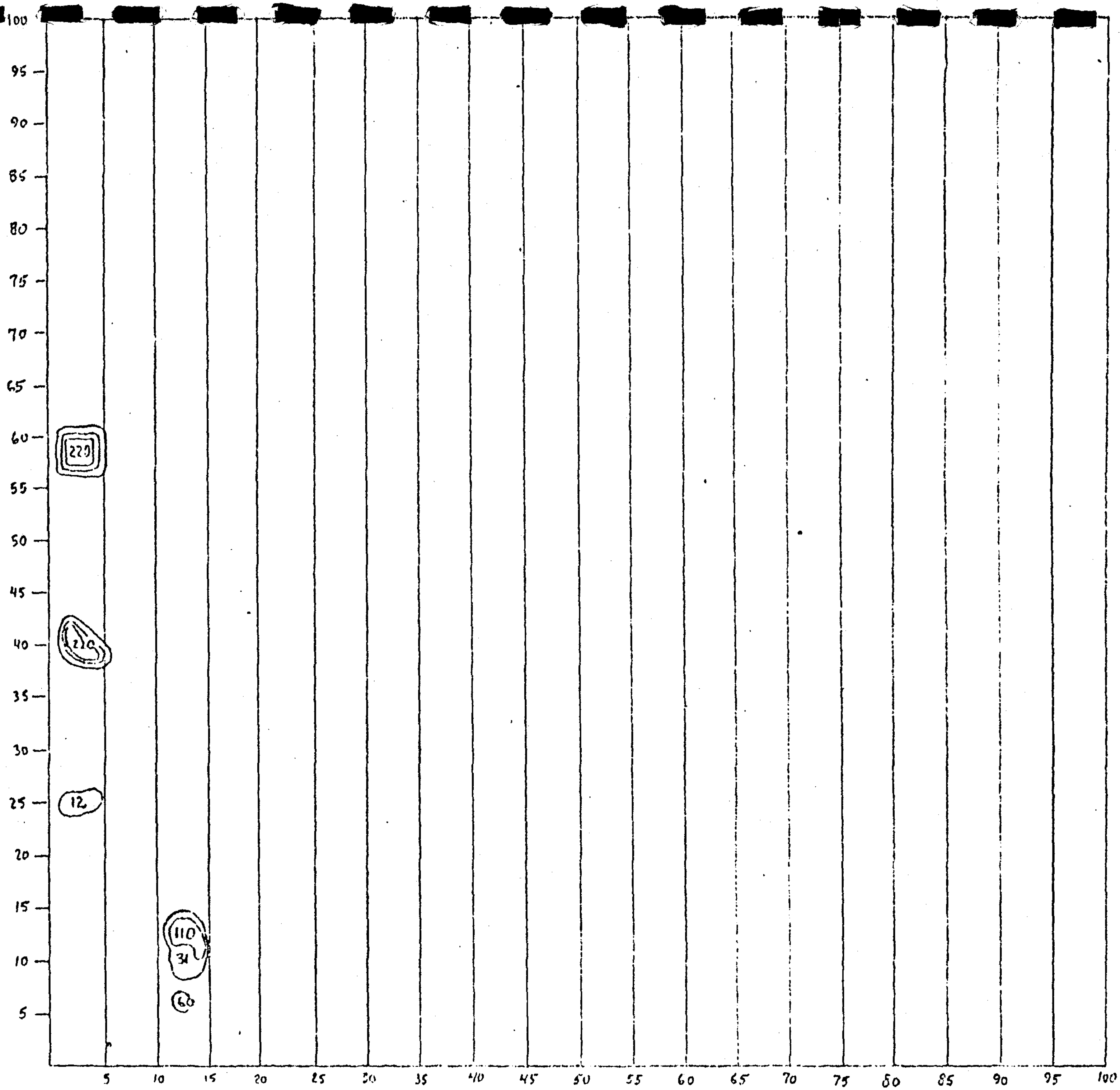
SURVEY PLOT #1

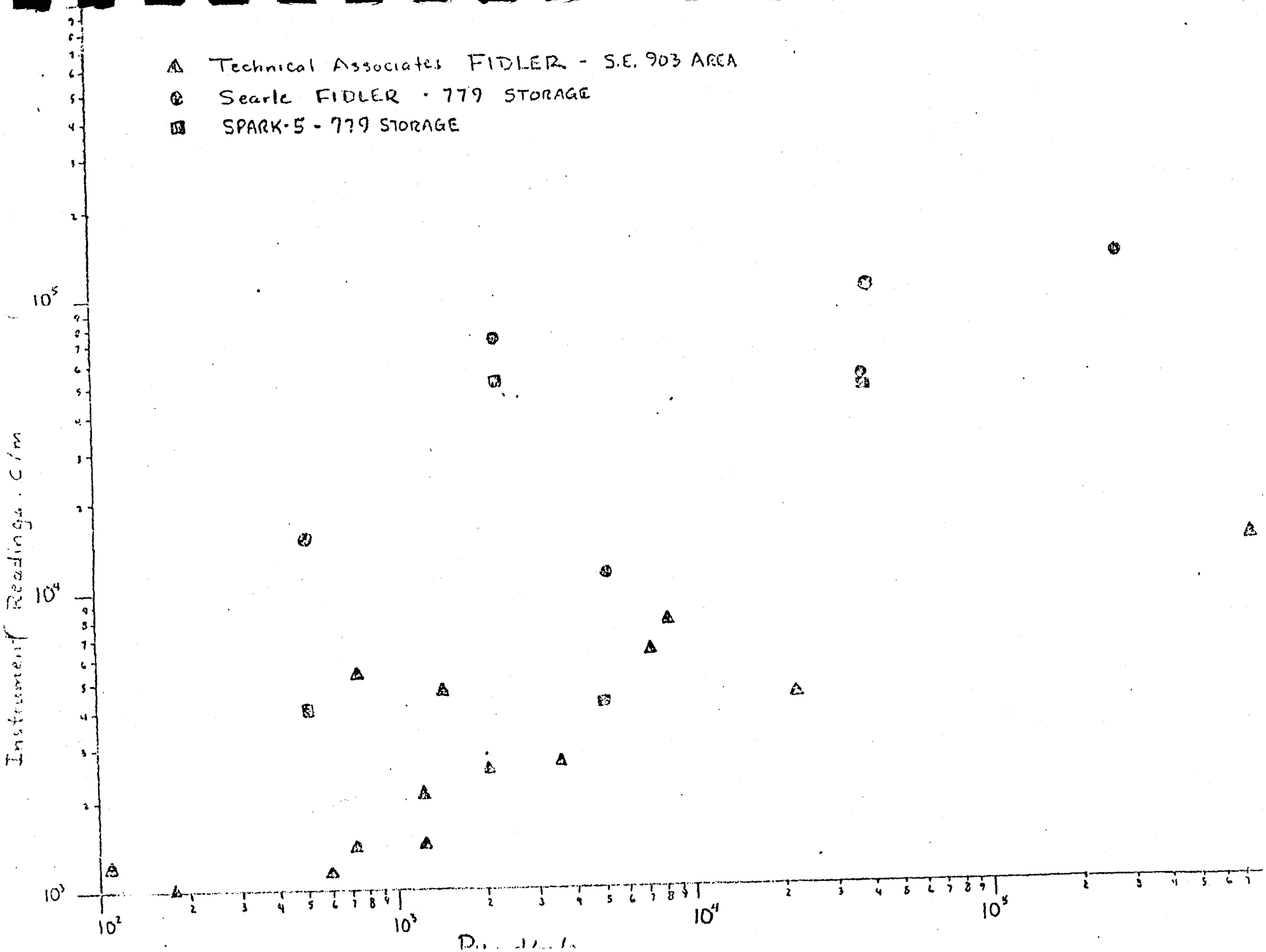
ISOPLETHS DERIVED FROM "SPARK-5" READINGS, CONVERTED TO dl/m/g.

CONTOUR INTERVAL 100 dl/m/g

OUTER CONTOUR 10 dl/m/g

SCALE: 3/4" = 10'




Technical Associates FIDLER - S.E. 903 AREA
Searle FIDLER - 779 STORAGE
SPARK-5 - 779 STORAGE
Instrument Readings, c/m
10^3
10^4
10^5
10^2

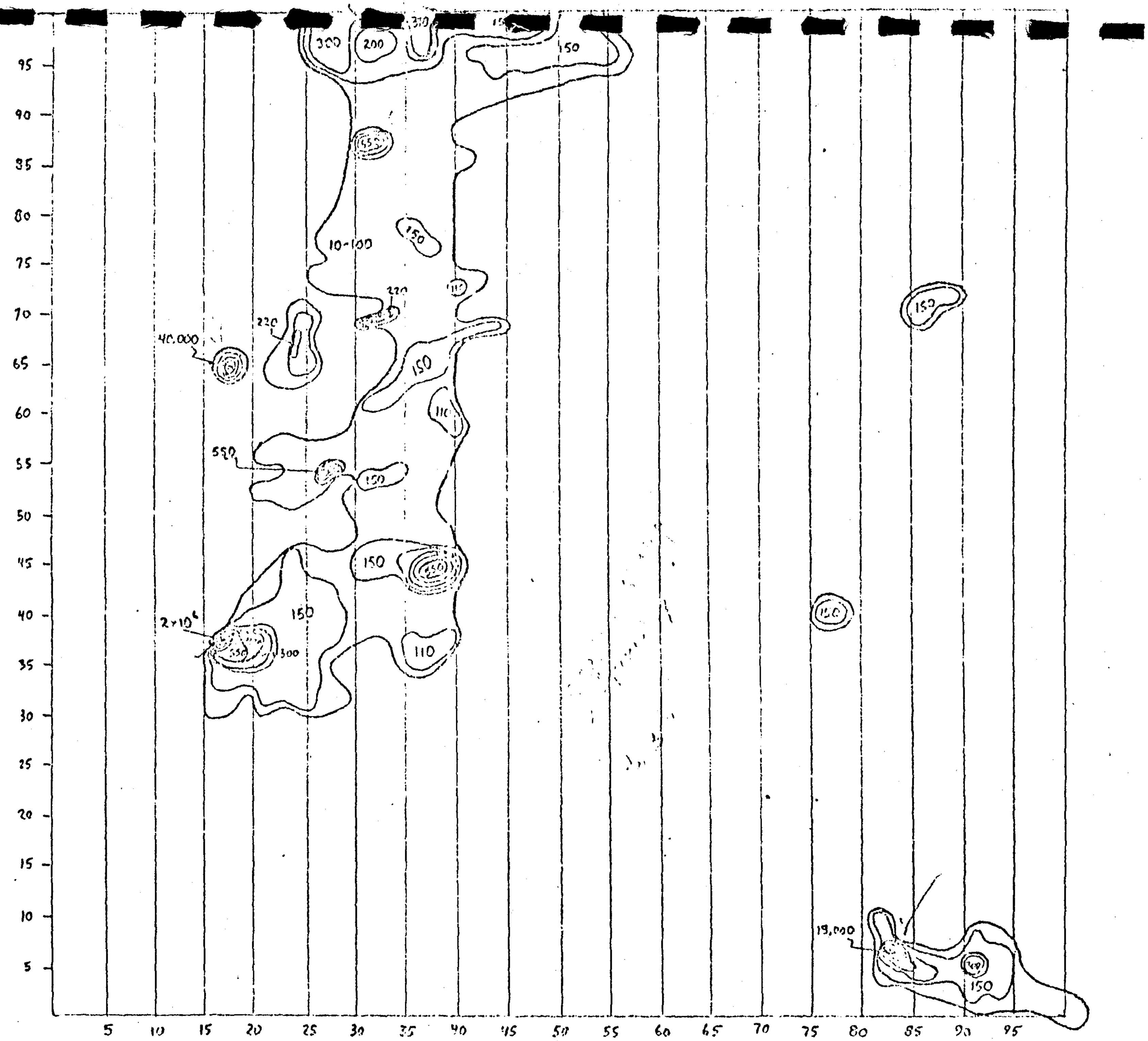
SURVEY PLOT # 2

ISOPLETHS DERIVED FROM "SPARK-5" READINGS, CONVERTED TO d/m/g

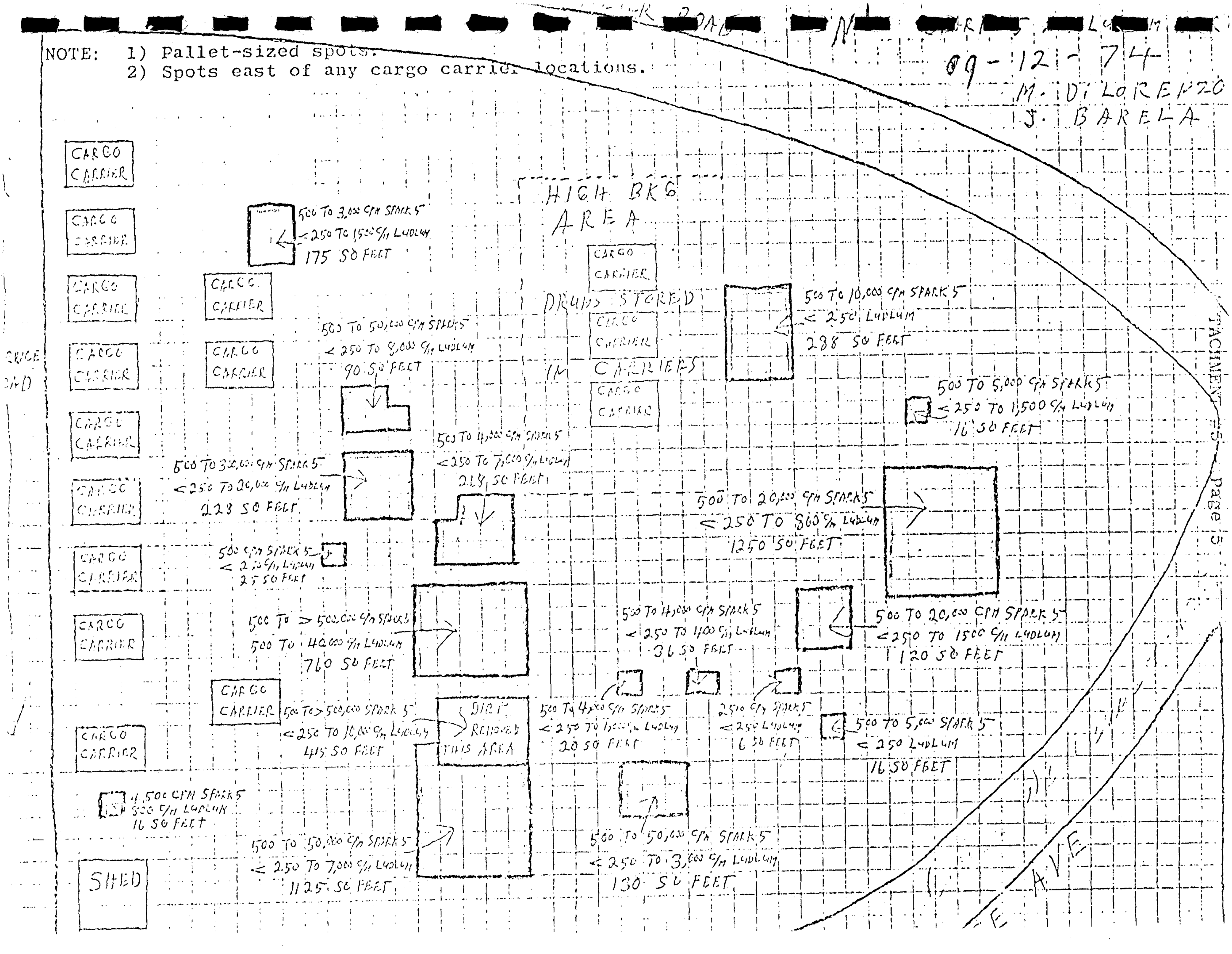
CONTOUR INTERVAL 100 d/m/g.

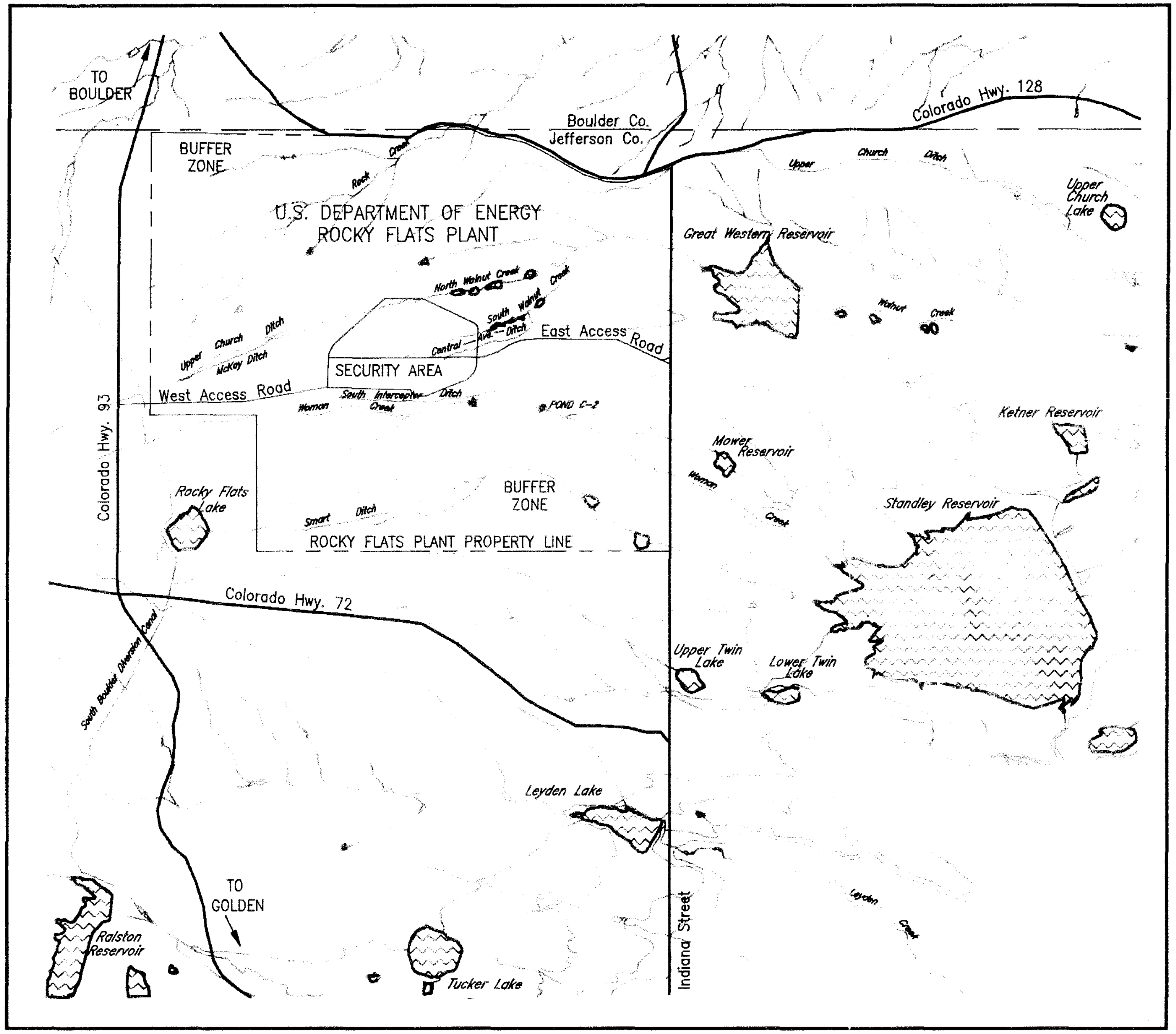
OUTER CONTOUR 10 d/m/g.

SCALE: 3/4" = 10'



NOTE: 1) Pallet-sized spots.
2) Spots east of any cargo carrier locations.





0 1/2 1 MILE
SCALE: 1" = 1 MILE

SOURCE: EG&G 1991b

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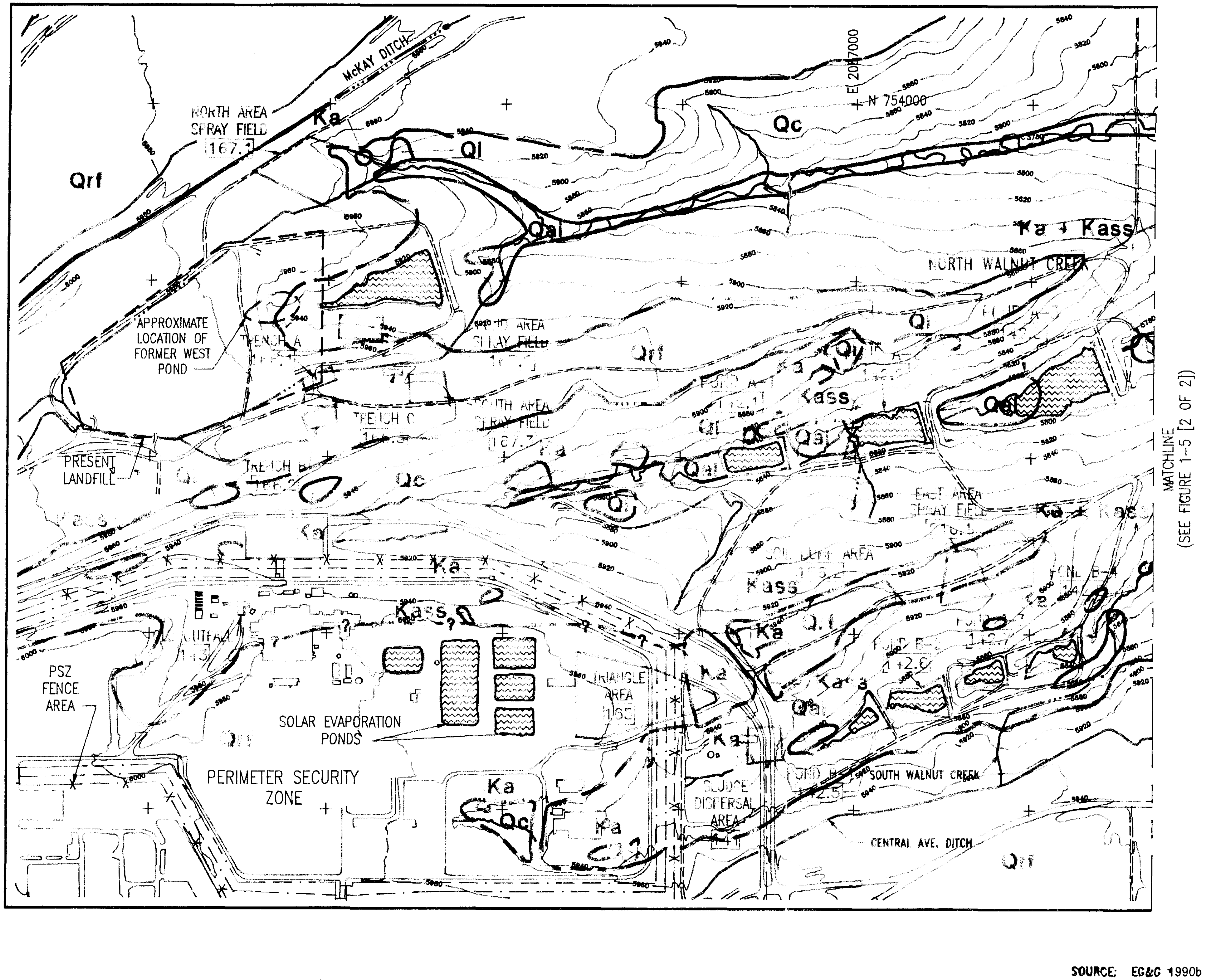
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT
BOUNDARIES AND BUFFER ZONE

FIGURE 1-2 APRIL 1991



DRAFT
FOR COMMENTS AND DISCUSSION ONLY

N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

PERIMETER SECURITY ZONE

DIRT ROAD

CONTACT

DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED.

QUATERNARY

RECENT VALLEY FILL
LANDSLIDE
COLLUVIUM
TERRACE ALLUVIUM
SLOCUM ALLUVIUM
VERDOS ALLUVIUM
ROCKY FLATS ALLUVIUM

CRETACEOUS

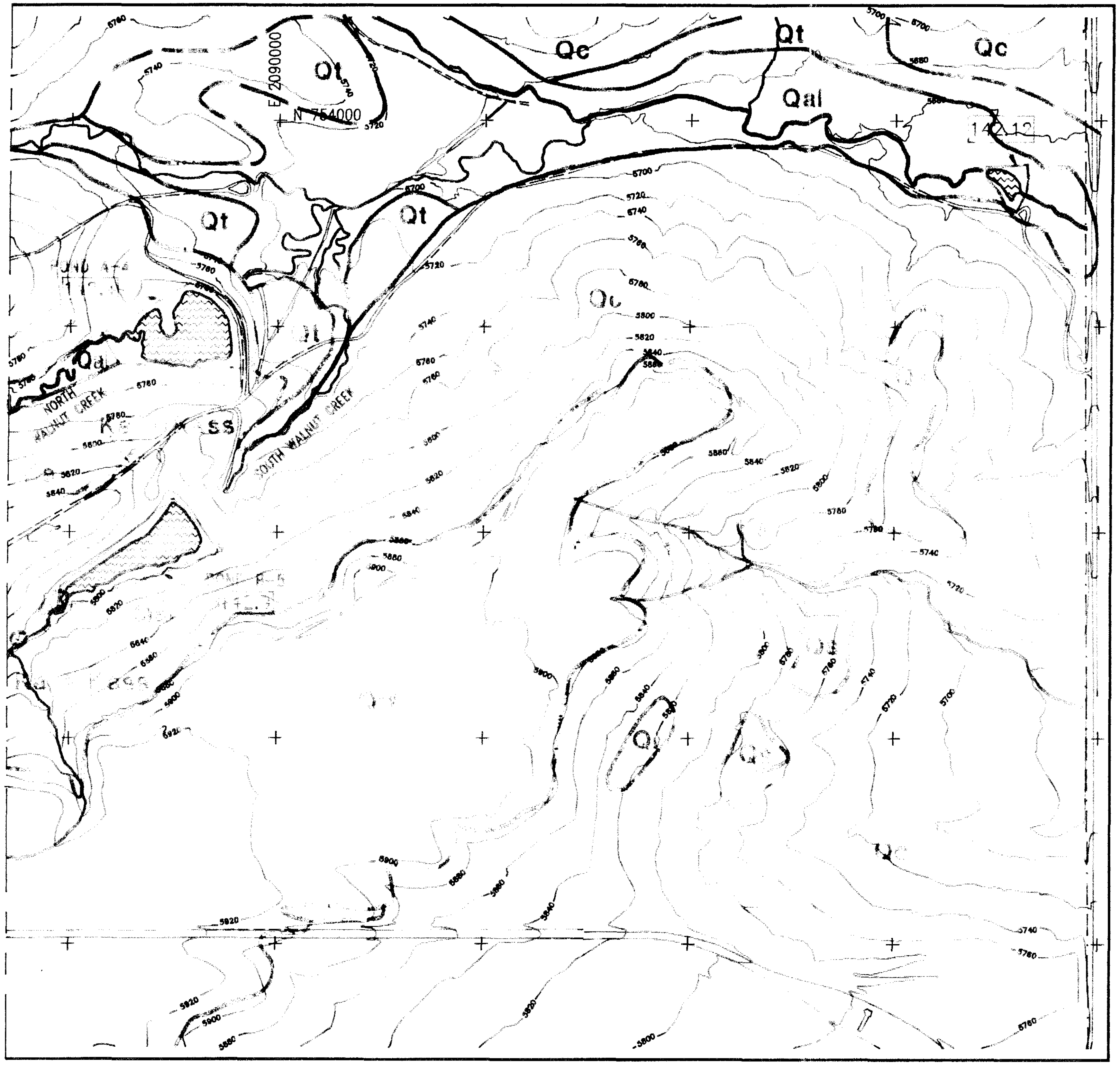
ARAPAHOE FORMATION, SANDSTONE
ARAPAHOE FORMATION, CLAYSTONE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY MAP

FIGURE 1-5 (1 OF 2) APRIL 1991



SOURCE: EG&G 1990b

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N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

INTERMITTENT STREAM

DIRT ROAD

CONTACT
DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED

QUATERNARY
RECENT VALLEY FILL
LANDSLIDE
COLLUVIUM
TERRACE ALLUVIUM
SLOCUM ALLUVIUM
VERDOS ALLUVIUM
ROCKY FLATS ALLUVIUM

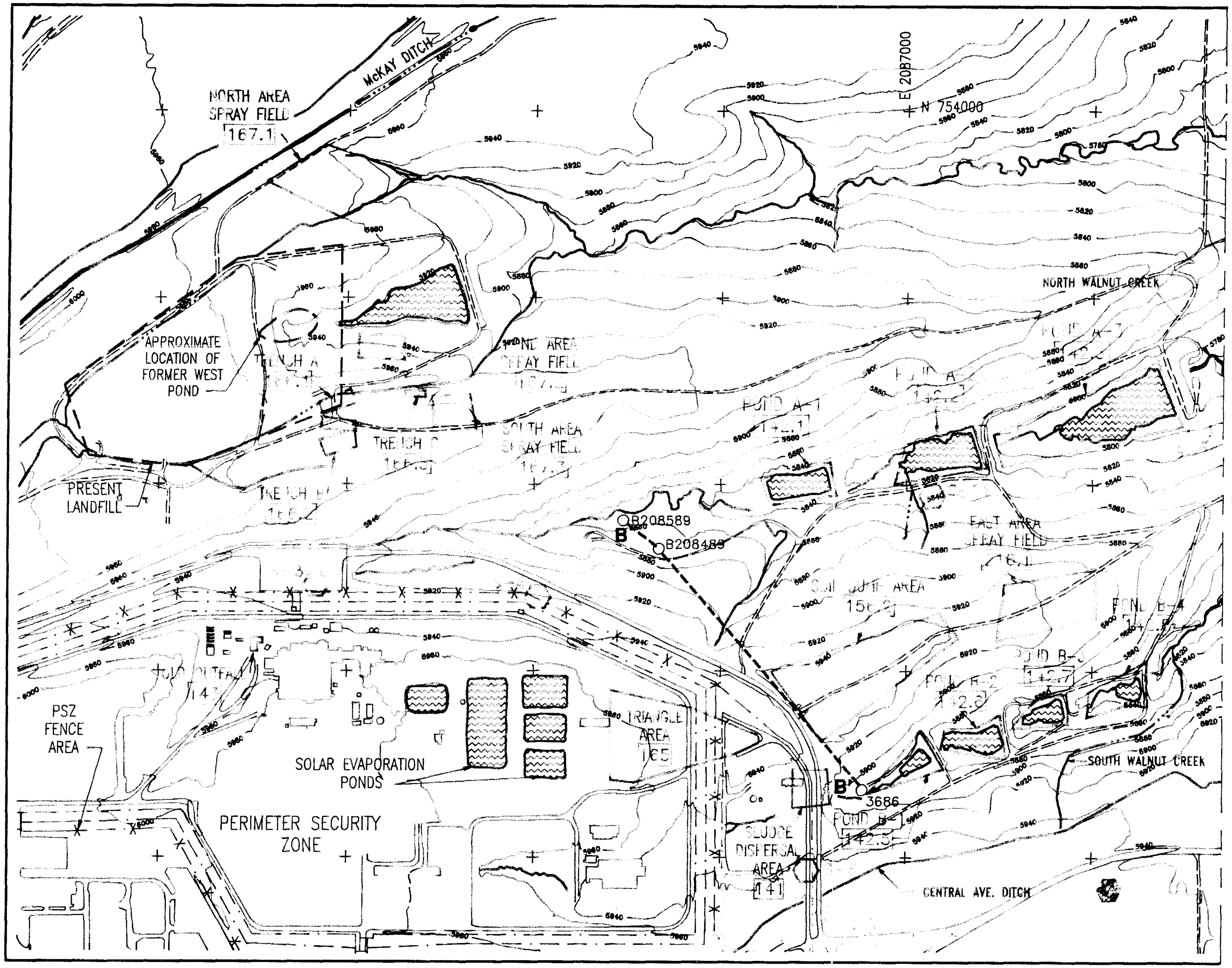
CRETACEOUS
ARAPAHOE FORMATION, SANDSTONE
ARAPAHOE FORMATION, CLAYSTONE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY MAP

FIGURE 1-5 (2 OF 2) APRIL 1991



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N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

PERIMETER SECURITY ZONE

DIRT ROAD

EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

3686 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL

B - - - B' CROSS-SECTION B-B' SEE FIGURE 2-5

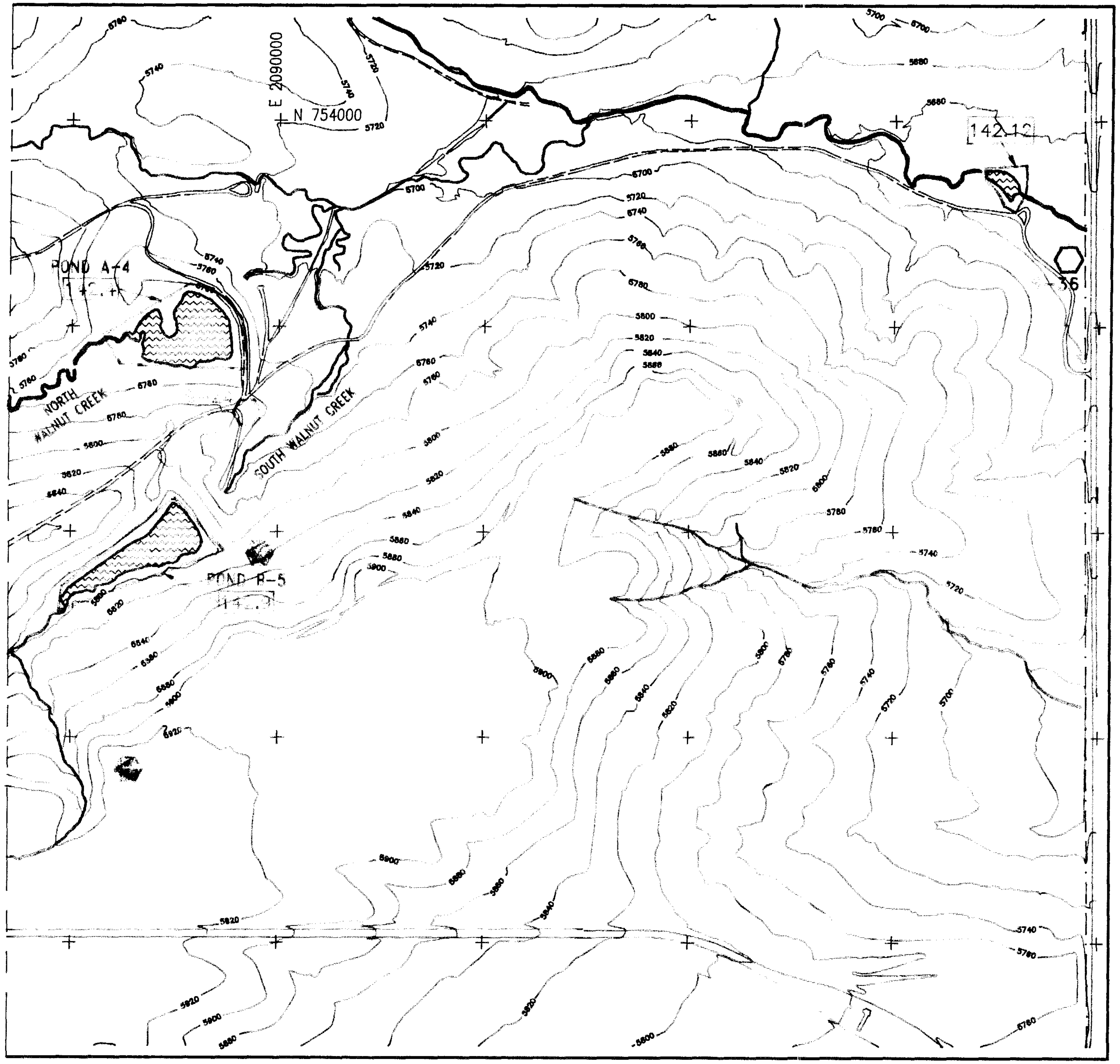
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES NORTH AND SOUTH WALNUT CREEKS

FIGURE 2-1 (1 OF 2) APRIL 1991

MATCHLINE
(SEE FIGURE 2-1 [2 OF 2])



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N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

DIRT ROAD

EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

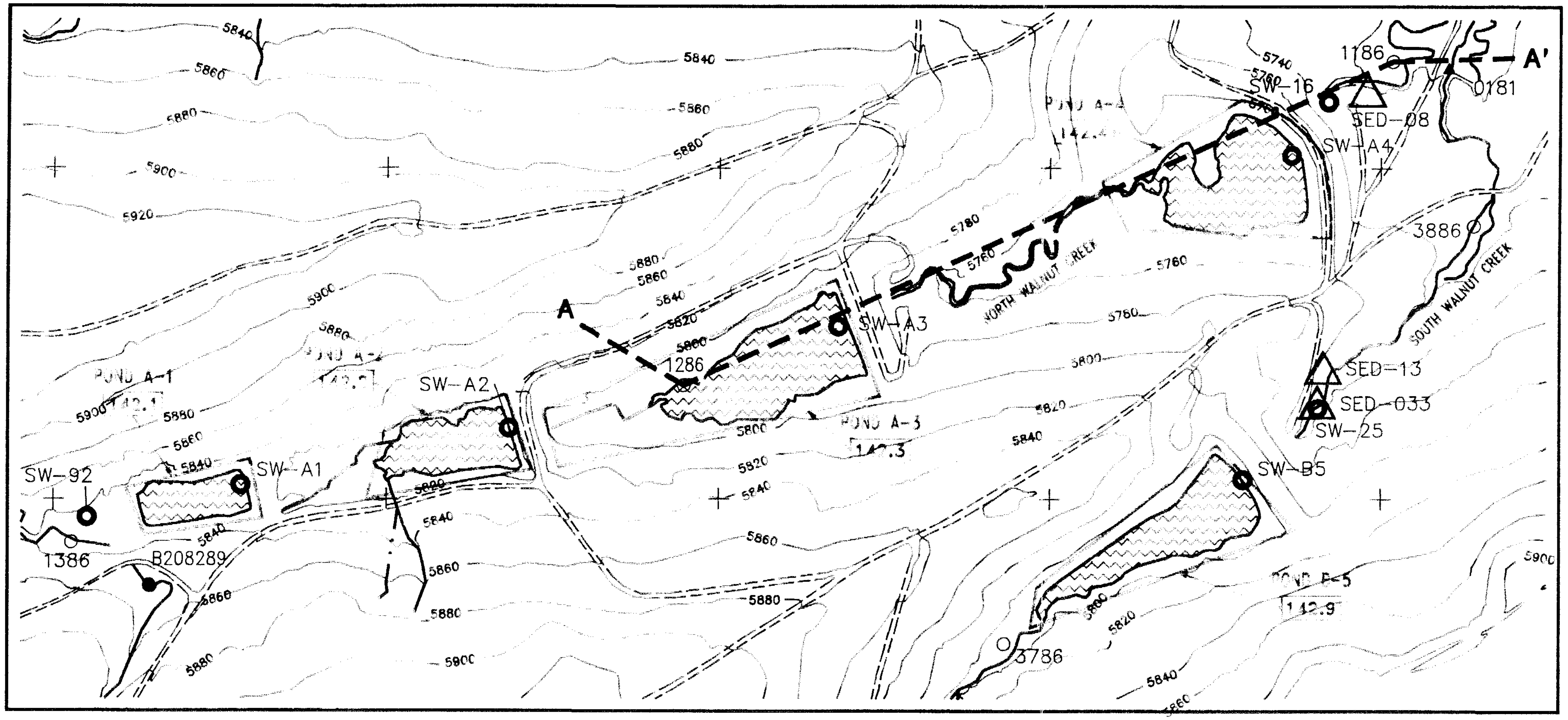
PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES NORTH AND SOUTH WALNUT CREEKS

FIGURE 2-1 (2 OF 2) APRIL 1991



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N

0 200 400
SCALE: 1" = 400'

EXPLANATION

- IHSS — INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 — EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 — EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 — EXISTING SEDIMENT SAMPLING LOCATION
- 3087 — EXISTING BEDROCK GROUNDWATER MONITORING WELL
- 0181 — EXISTING PRE-1986 WELL
- INTERMITTENT STREAM
- DIRT ROAD
- A — A' CROSS-SECTION A-A', SEE FIGURE 2-6

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Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
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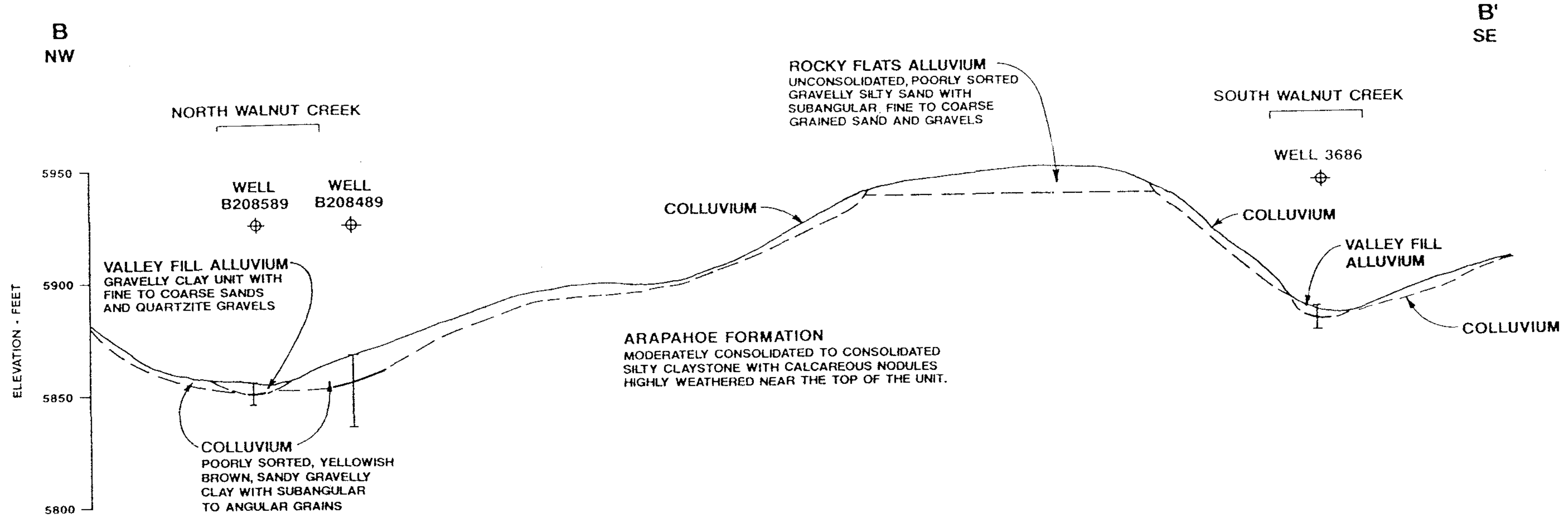
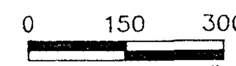
IHSSs 142.1-4
A-SERIES DETENTION PONDS
(A-1, A-2, A-3, AND A-4)
ALONG NORTH WALNUT CREEK

FIGURE 2-2 APRIL 1991





HORIZONTAL SCALE: 1" = 300'

EXPLANATION

- ALLUVIAL MONITORING WELL
- INFERRED BOUNDARY OF ROCK LIMITS
- 4X VERTICAL EXAGGERATION
- CROSS-SECTIONAL LINE ON FIGURE 2-1

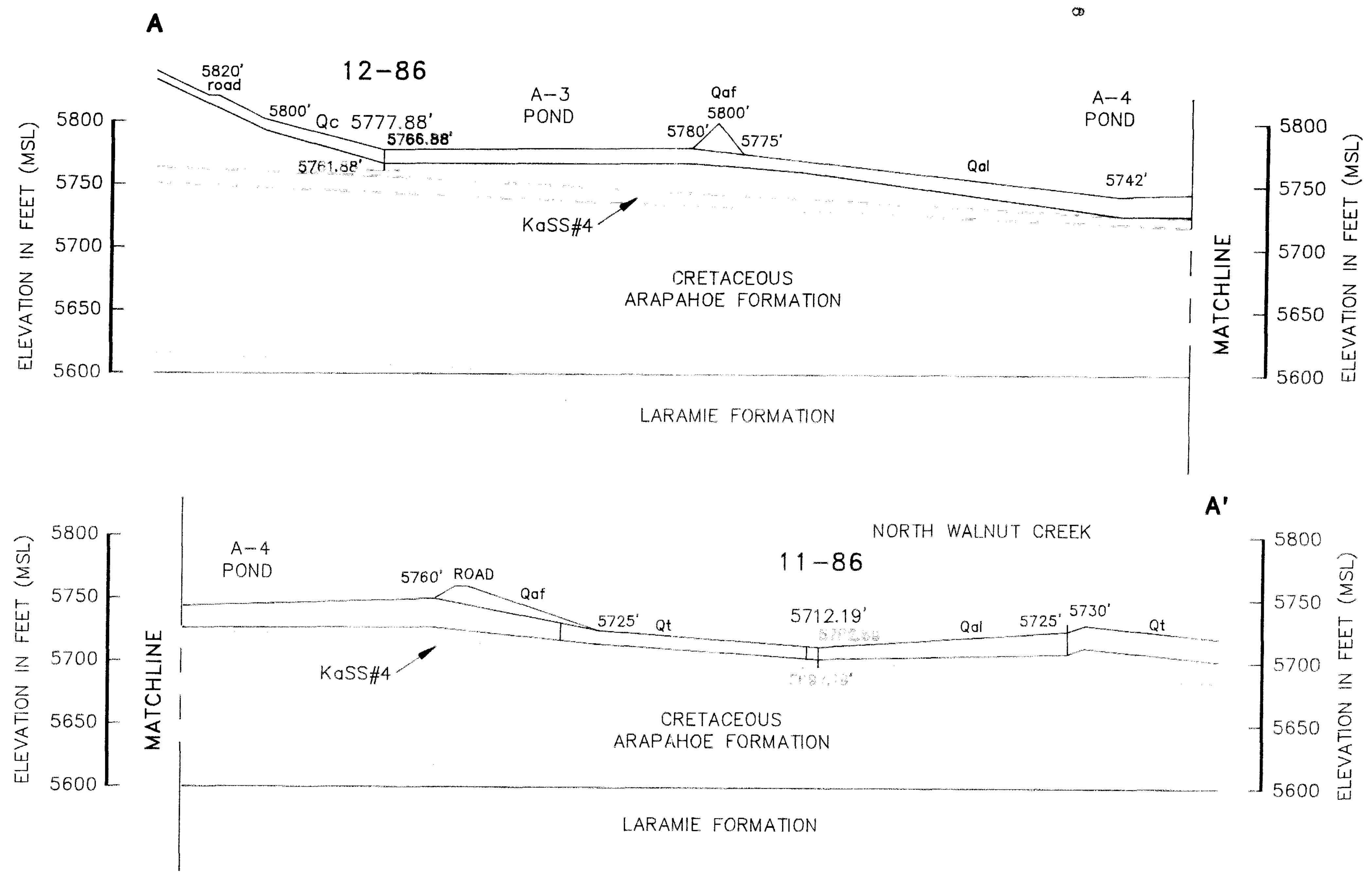
[redacted]

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

GEOLOGIC CROSS-SECTION ACROSS NORTH AND SOUTH WALNUT CREEKS

FIGURE 2-5

APRIL 1991



VERTICAL SCALE: 1" = 100'
HORIZONTAL SCALE: 1" = 200'

Source: EG&G 1990e

EXPLANATION

QUATERNARY

Qal = Recent Valley Fill
Qc = Colluvium
Qaf = Artificial Fill
Qt = Terrace Alluvium

CRETACEOUS

Kass#4 = Arapahoe Sandstone No.4

5968'= Ground Surface Elevation
5956'= Bedrock Surface Elevation

CROSS SECTIONAL LINE ON FIGURE 2-2

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Rocky Flats Plant, Golden, Colorado

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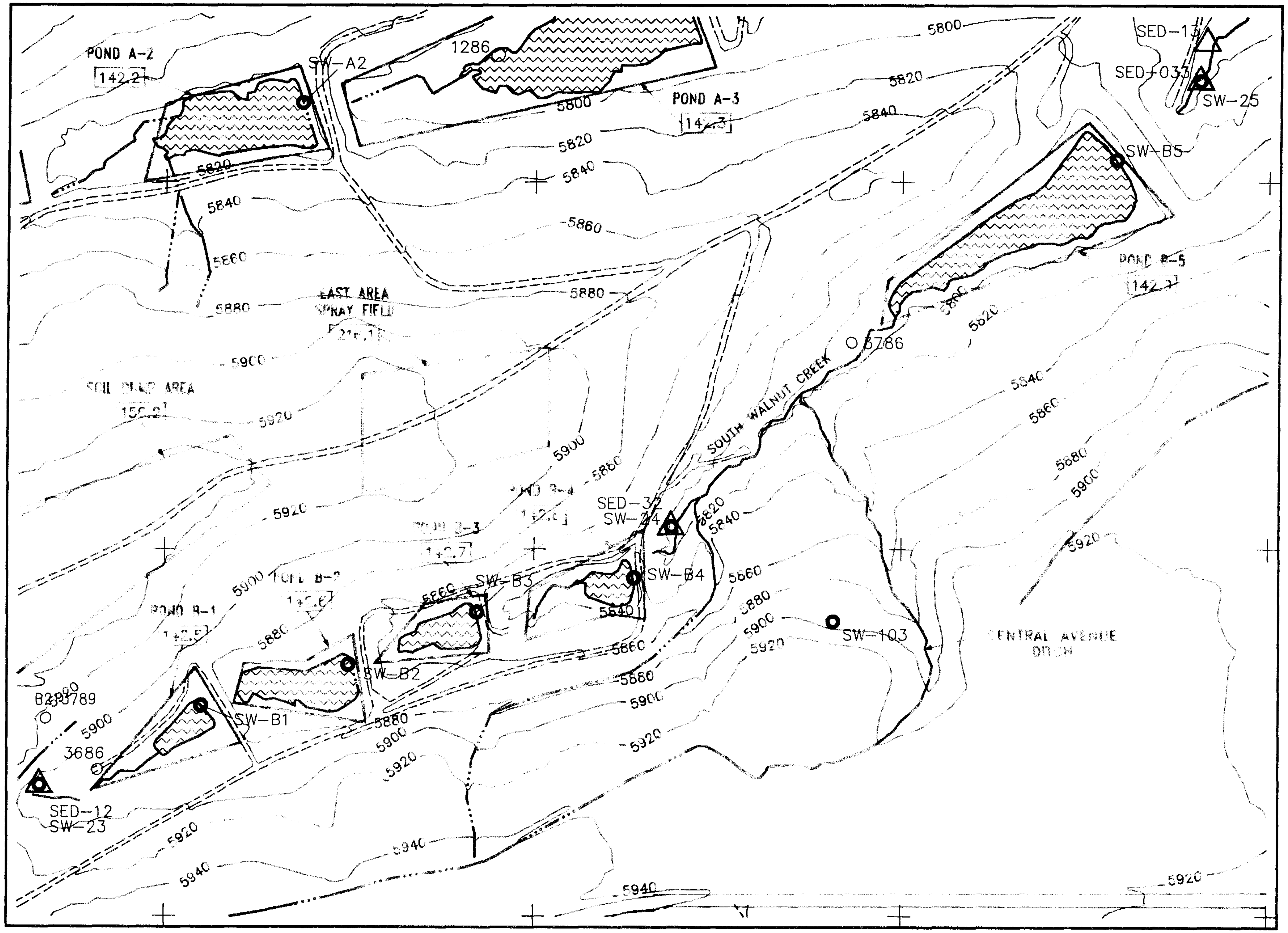
PHASE I RFI/RI WORK PLAN

GEOLOGIC CROSS-SECTION A-A'

FIGURE 2-6 APRIL 1991



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N

0 150 300
SCALE: 1" = 300'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
968	ROCKY FLATS BLDG. NO.

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

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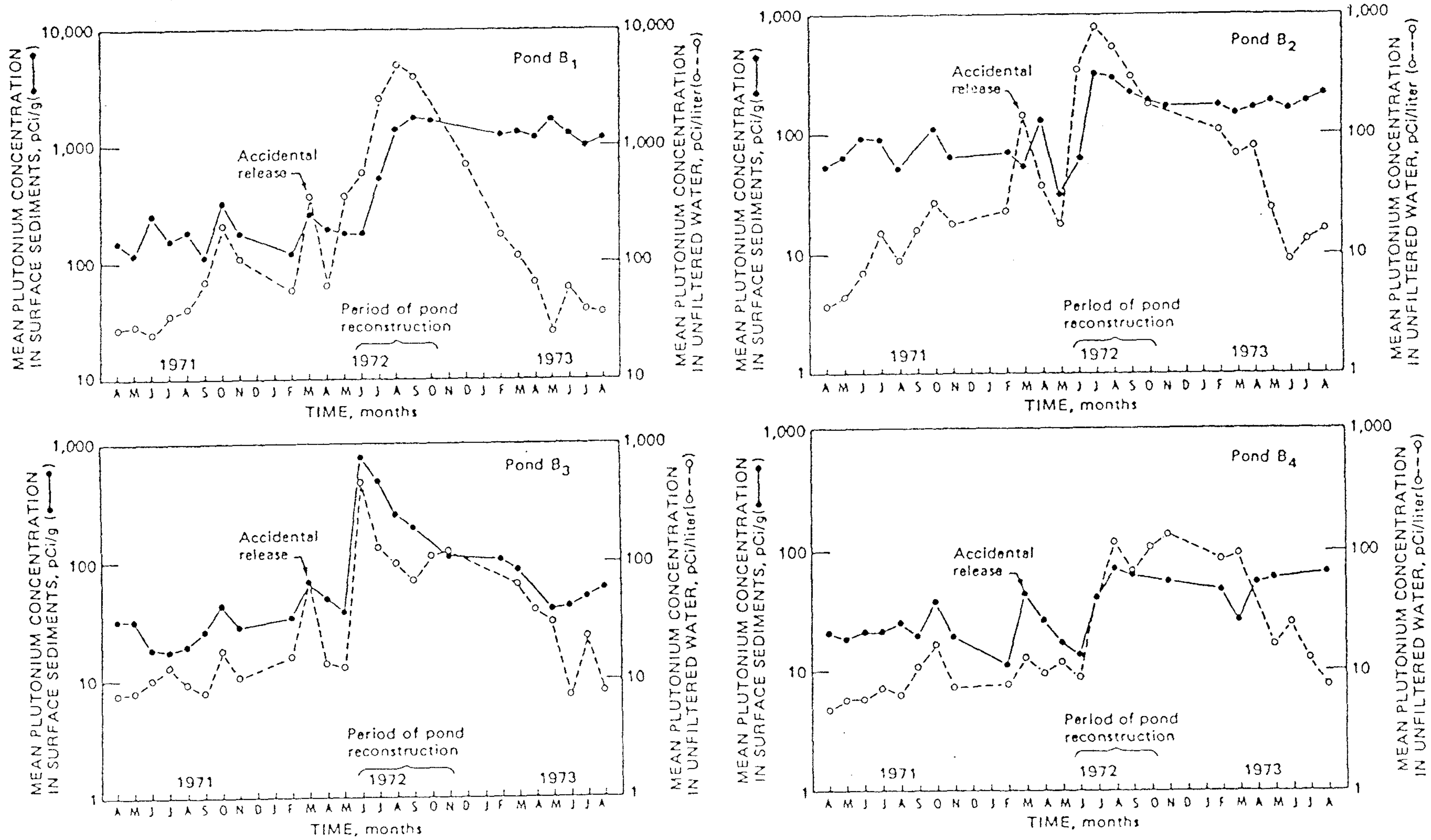
IHSSs 142.5-9,
B-SERIES DETENTION PONDS
ALONG SOUTH WALNUT CREEK,
IHSS 216.1 EAST AREA SPRAY FIELD

FIGURE 2-7 APRIL 1991



SOURCE: PAINE, 1980

DRAFT [redacted] LY

U.S. [redacted]
Rocky Flats Plant, Golden, Colorado

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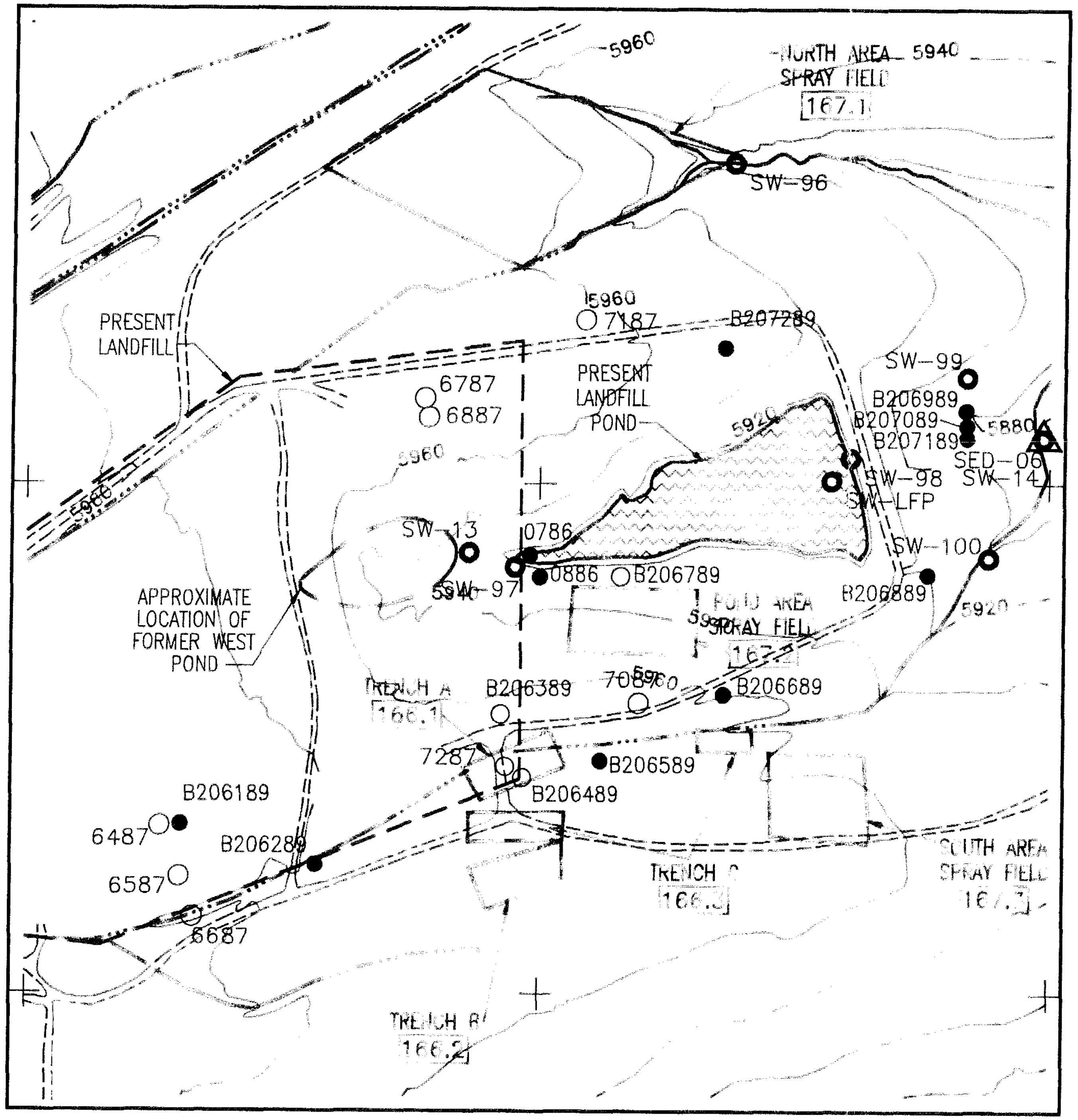
MEAN PLUTONIUM CONCENTRATIONS IN SURFACE SEDIMENTS (pCi/g) AND MEAN PLUTONIUM CONCENTRATIONS IN UNFILTERED WATER (pCi/l) FOR PONDS B-1, B-2, B-3, AND B-4

FIGURE 2-8

APRIL 1991



DRAFT
FOR COMMENTS AND DISCUSSION ONLY

N

0 150 300
SCALE: 1" = 300'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
3087	EXISTING BEDROCK GROUNDWATER MONITORING WELL
	INTERMITTENT STREAM
	DIRT ROAD

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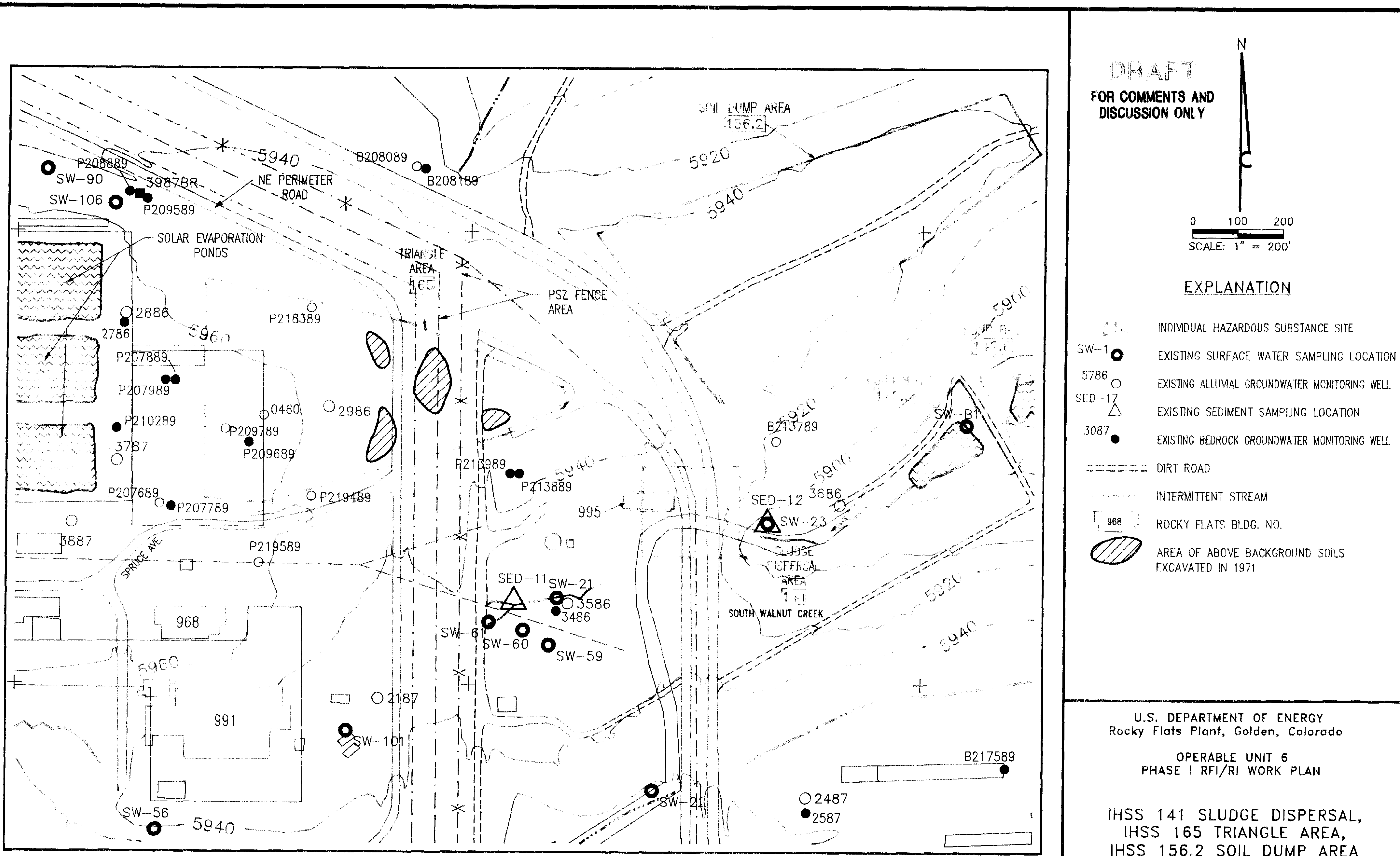
IHSSs 166.1-3, TRENCHES A, B, & C
IHSSs 167.1-3 NORTH AREA,
POND AREA AND SOUTH AREA
SPRAY FIELDS

FIGURE 2-10 APRIL 1991



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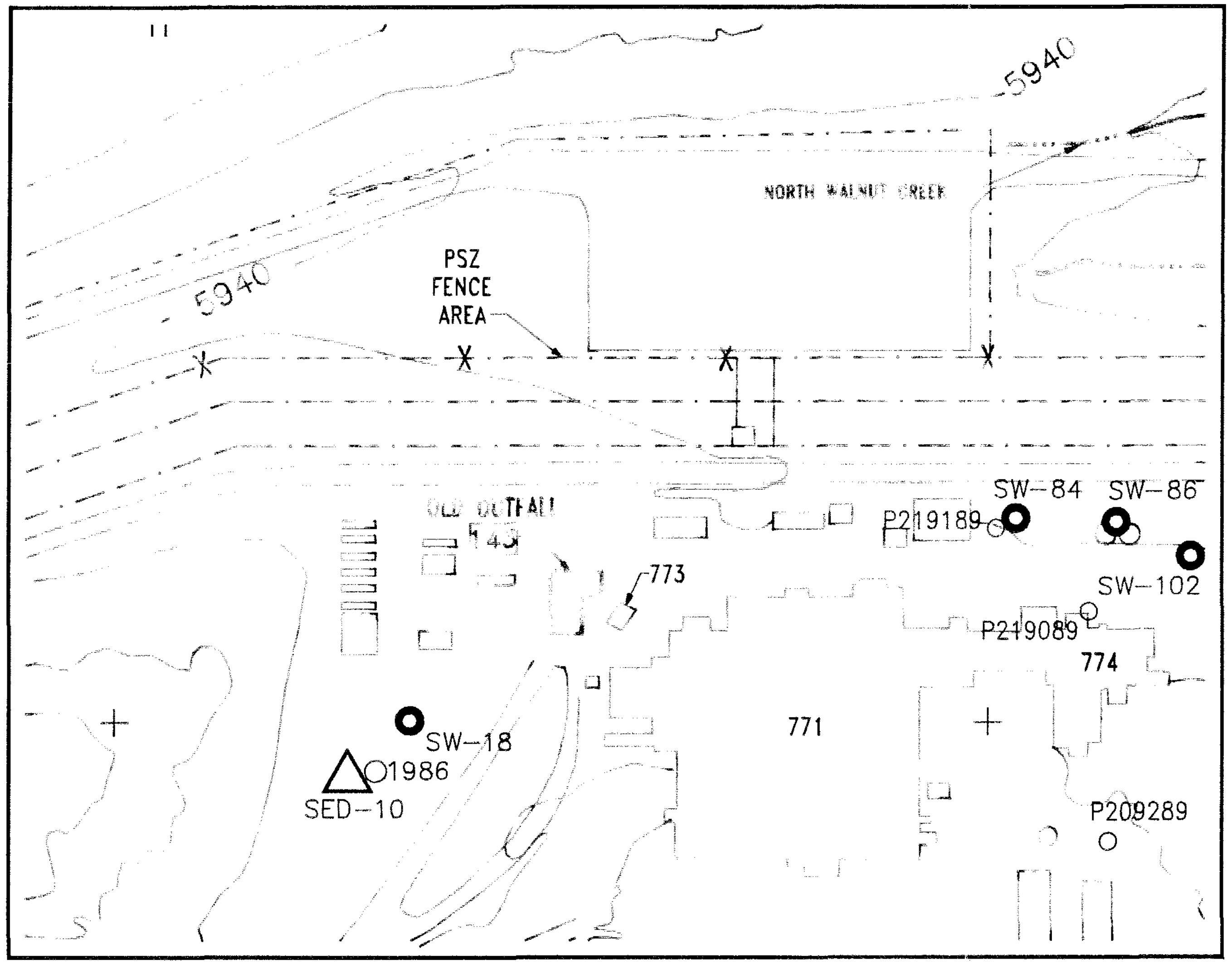
PHASE I RFI/RI WORK PLAN

IHSS 141 SLUDGE DISPERSAL,
IHSS 165 TRIANGLE AREA,
IHSS 156.2 SOIL DUMP AREA

FIGURE 2-11 APRIL 1991



DRAFT

[redacted]

N

0 100 200
SCALE: 1" = 200'

EXPLANATION

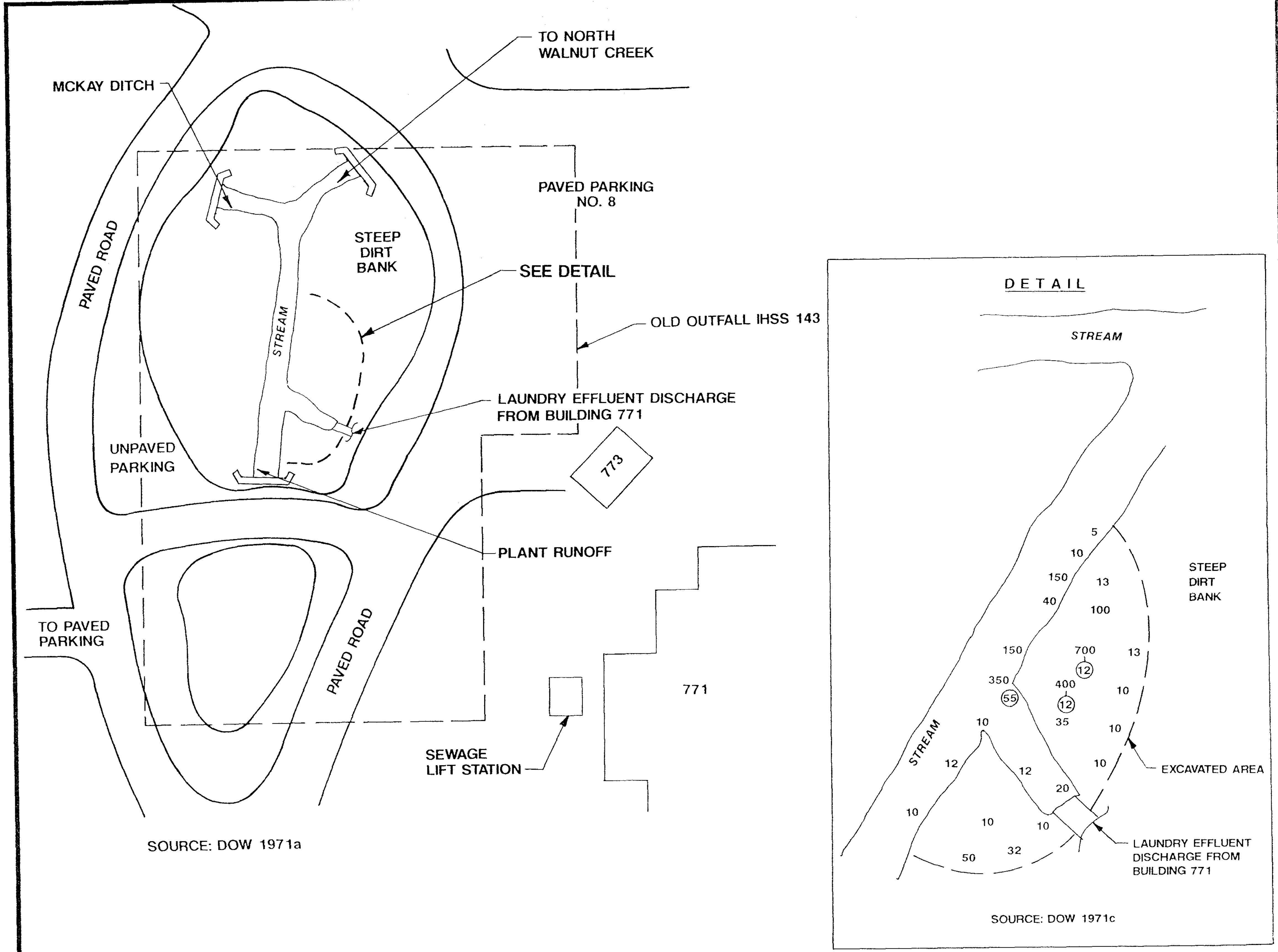
	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
968	ROCKY FLATS BLDG. NO.

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

IHSS 143 OLD OUTFALL AREA

FIGURE 2-12 APRIL 1991



N

SCALE: NOT TO SCALE

EXPLANATION

12 CONCENTRATION OF SOIL SAMPLE IN d/m/gm

(12) CONCENTRATION OF RESAMPLED SOIL SAMPLE IN d/m/gm AFTER FURTHER DIGGING

[redacted]

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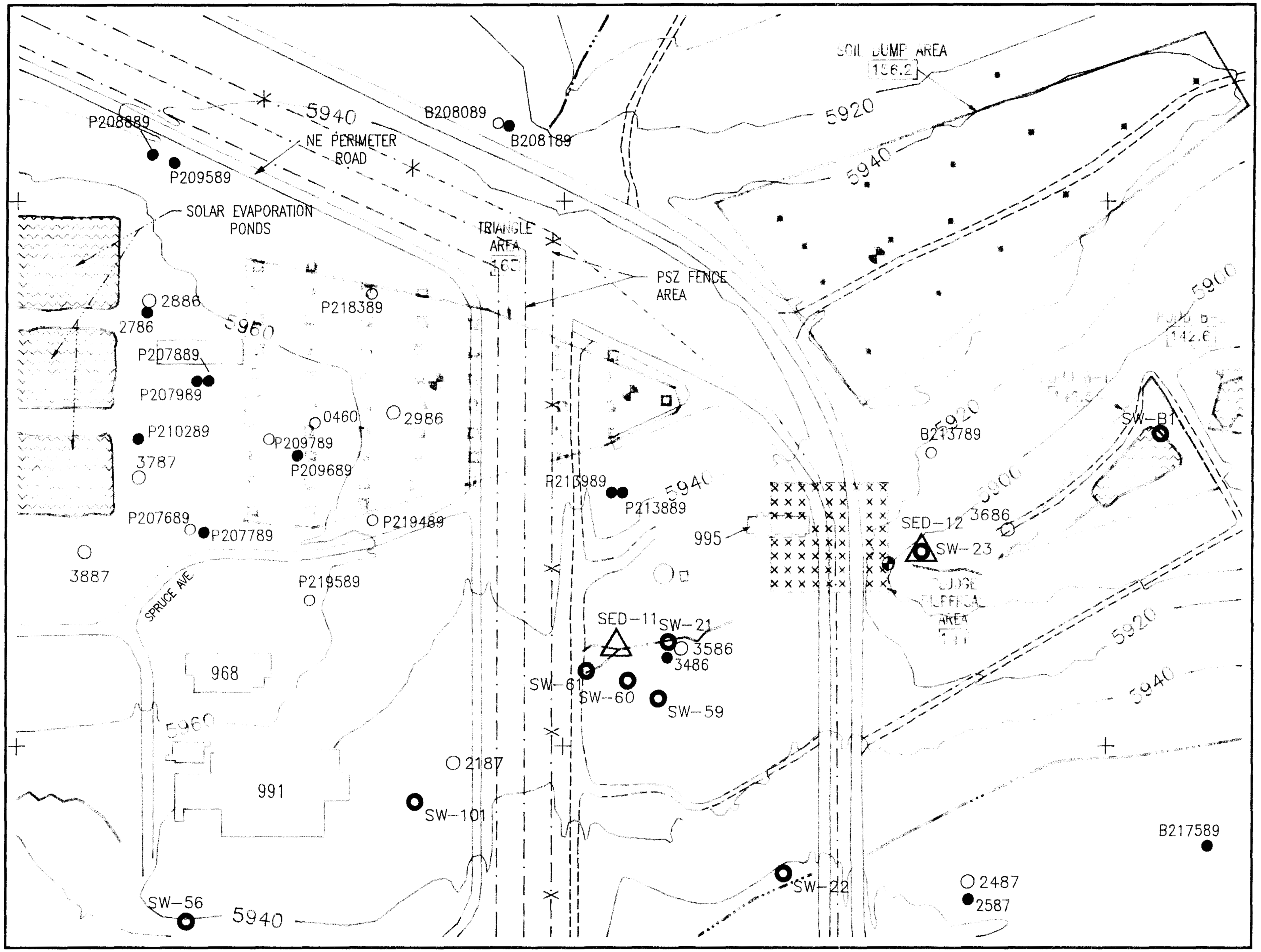
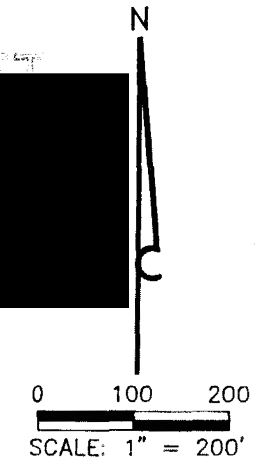
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

IHSS 143 OLD OUTFALL AREA
LOCATION OF CULVERTS AND OUTFALL CATCHMENT BASIN IN FEBRUARY 1971 AND SOIL SAMPLE RESULTS DURING SOIL REMOVAL ACTIVITIES BETWEEN FEBRUARY AND AUGUST 1971

FIGURE 2-13 APRIL 1991



[redacted]



EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 — EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 — EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 — EXISTING SEDIMENT SAMPLING LOCATION
- 3087 — EXISTING BEDROCK GROUNDWATER MONITORING WELL
- DIRT ROAD
- INTERMITTENT STREAM
- 968 — ROCKY FLATS BLDG. NO.
- PROPOSED SOIL GAS SURVEY LOCATION[1]
- PROPOSED WELL LOCATION[1]
- PROPOSED SURFACE SAMPLING LOCATION[1]
- PROPOSED BORING AND SURFACE SAMPLING LOCATION[1]

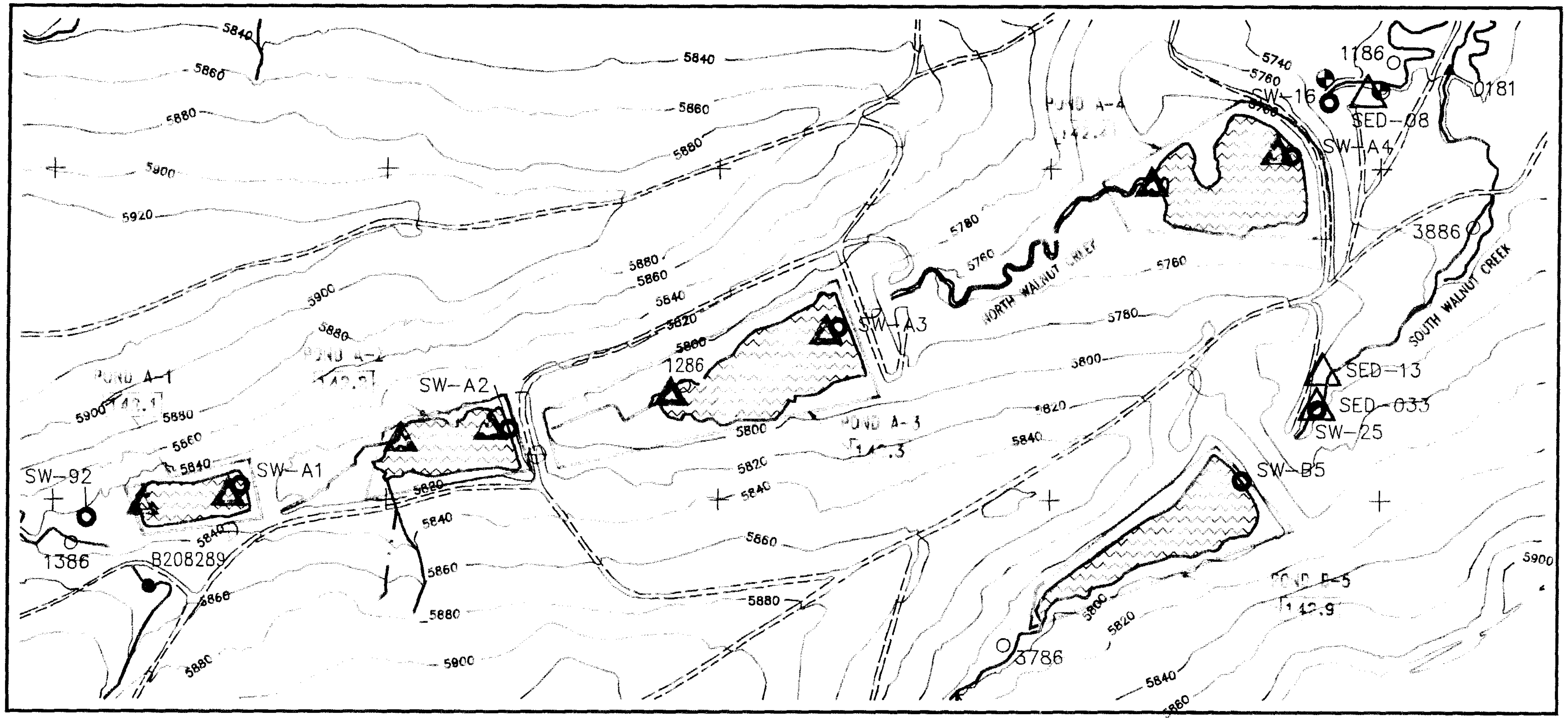
[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING AND WELL LOCATIONS
IHSS 141 SLUDGE DISPERSAL
IHSS 165 TRIANGLE AREA
IHSS 156.2 SOIL DUMP AREA

FIGURE 7-1 APRIL 1991



[redacted]

N

0 200 400
SCALE: 1" = 400'

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 EXISTING SEDIMENT SAMPLING LOCATION
- 3087 EXISTING BEDROCK GROUNDWATER MONITORING WELL
- 0181 EXISTING PRE-1986 WELL
- INTERMITTENT STREAM
- DIRT ROAD
- PROPOSED WELL LOCATION[1]
- PROPOSED SEDIMENT SAMPLE LOCATION[1]
- PROPOSED BEDROCK WELL LOCATIONS FOR SITE-WIDE GEOLOGICAL CHARACTERIZATION PROGRAM[1]

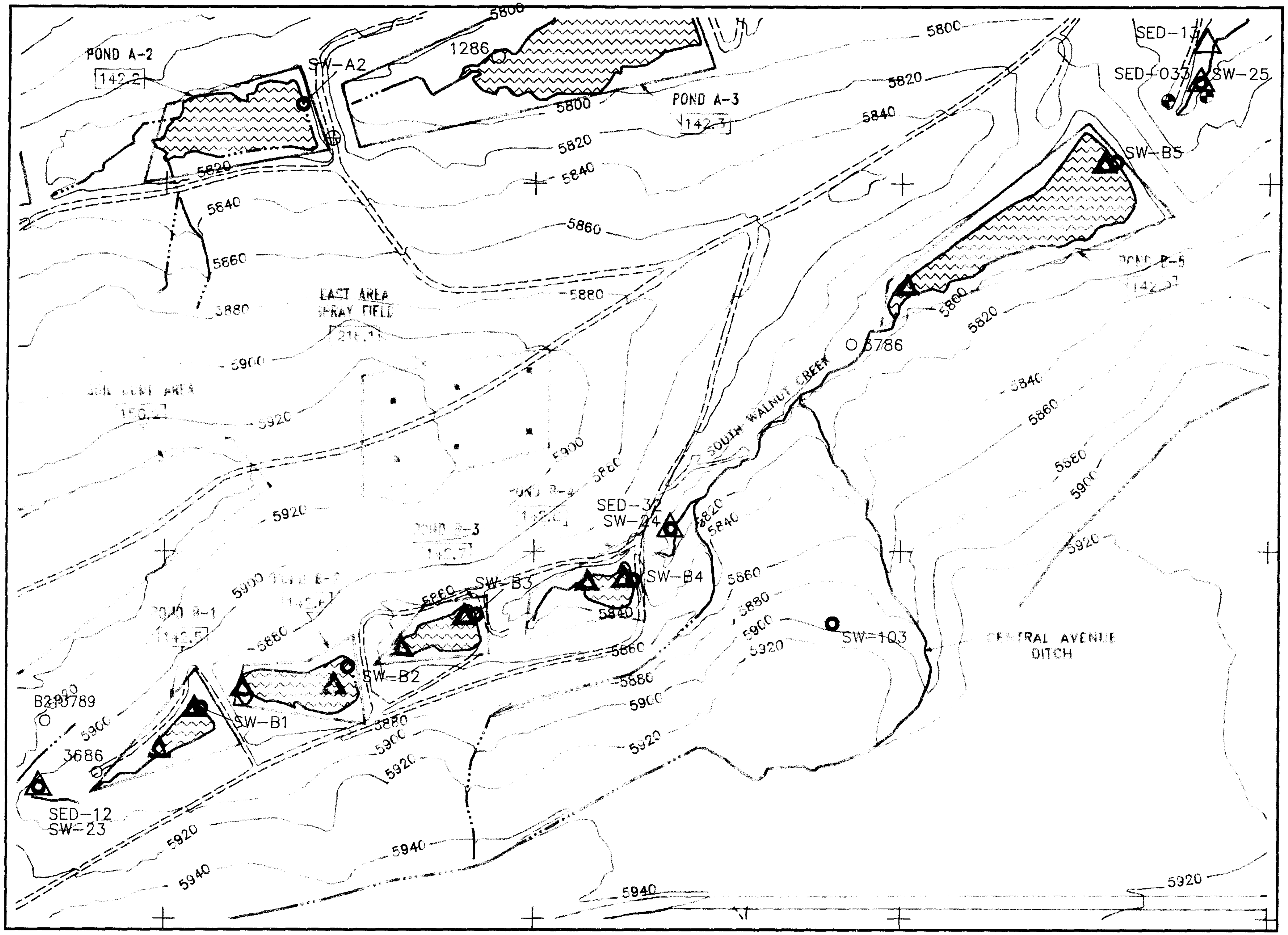
[1]ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSSs 142.1-4
A-SERIES DETENTION PONDS
ALONG NORTH WALNUT CREEK

FIGURE 7-2 APRIL 1991



[redacted]

N

0 150 300
SCALE: 1" = 300'

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 EXISTING SEDIMENT SAMPLING LOCATION
- INTERMITTENT STREAM
- DIRT ROAD
- 968 ROCKY FLATS BLDG. NO.
- PROPOSED WELL LOCATION [1]
- PROPOSED BORING AND SURFACE SAMPLE [1] LOCATION
- PROPOSED SEDIMENT SAMPLE LOCATION [1,2]
- PROPOSED BEDROCK WELL LOCATIONS FOR SITE-WIDE GEOLOGICAL CHARACTERIZATION PROGRAM [1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

[2] THREE OTHER LOCATIONS IN EACH POND WILL BE SELECTED AT RANDOM

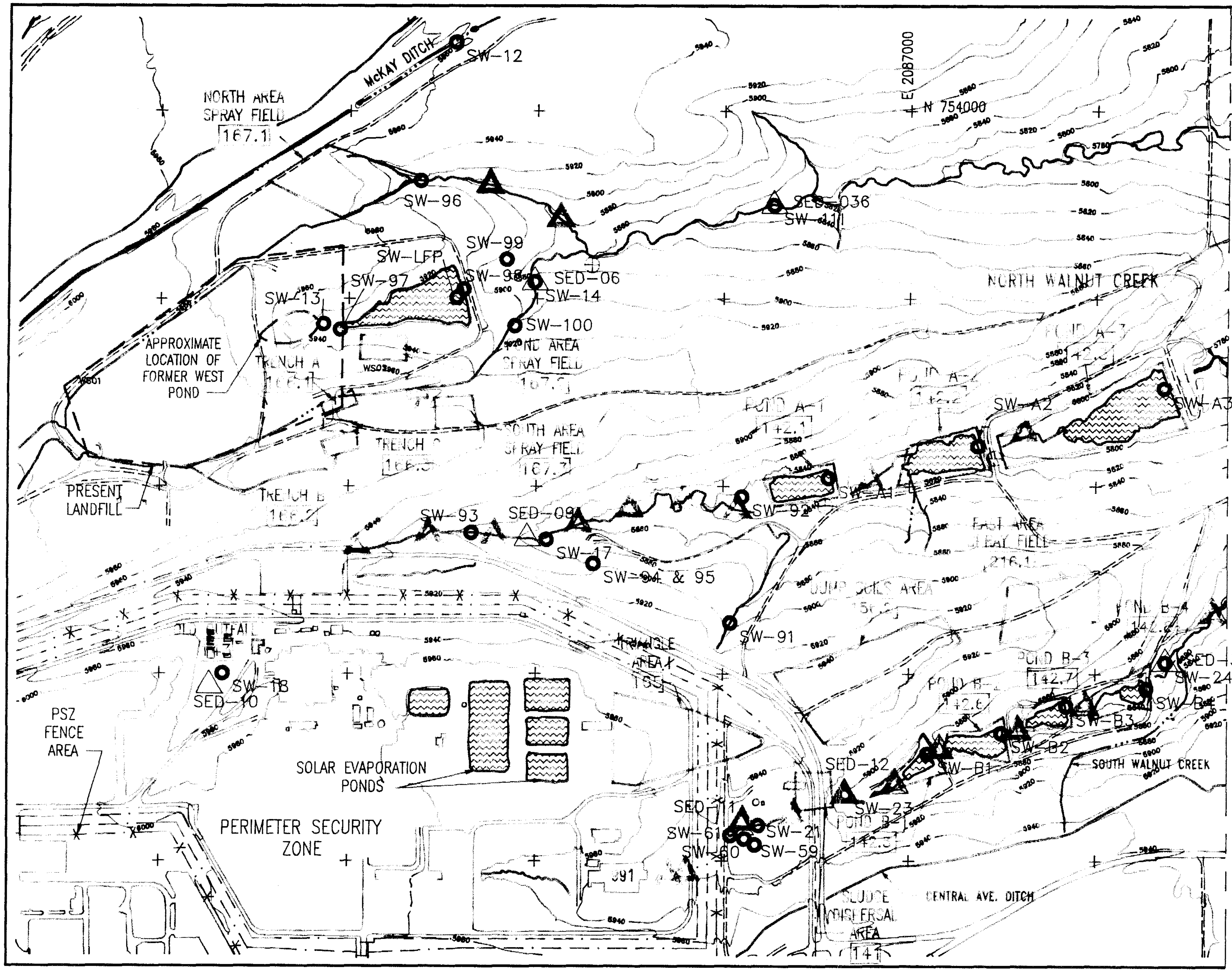
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSSs 142.5-9,
B-SERIES DETENTION PONDS
ALONG SOUTH WALNUT CREEK
IHSS 216.1 EAST AREA SPRAY FIELD

FIGURE 7-3 APRIL 1991

[redacted]



N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

SED-17 EXISTING SEDIMENT SAMPLE LOCATION

PERIMETER SECURITY ZONE

DIRT ROAD

PROPOSED LOCATIONS FOR SEDIMENT SAMPLES[1]

PROPOSED BEDROCK WELL LOCATIONS FOR SITE-WIDE GEOLOGICAL CHARACTERIZATION PROGRAM[1]

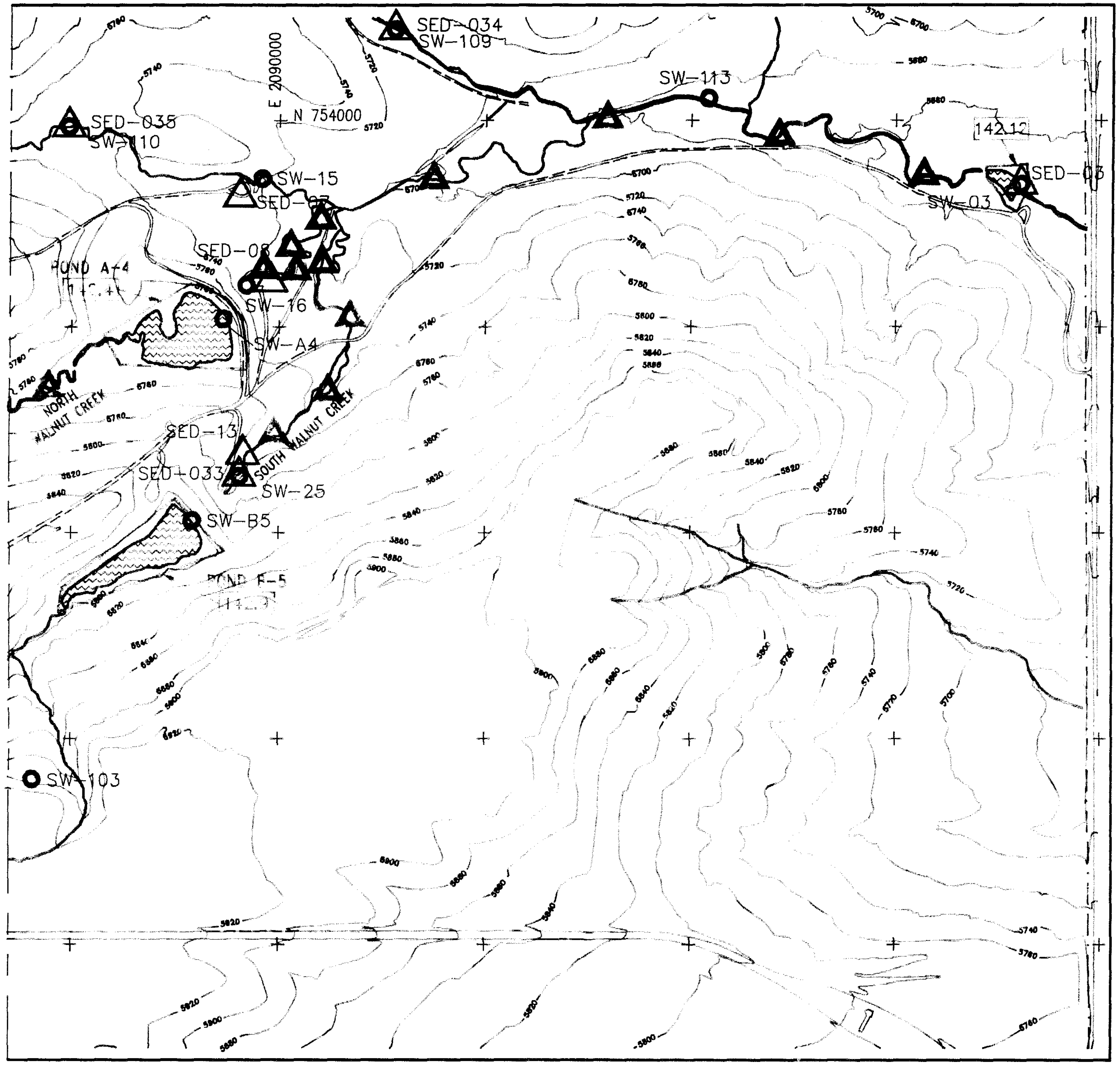
[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES AND SITE-WIDE PROGRAM BEDROCK WELLS ON NORTH AND SOUTH WALNUT CREEKS

FIGURE 7-4 (1 OF 2) APRIL 1991



MATCHLINE
(SEE FIGURE 7-4 [2 OF 2])

[redacted]

N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

115 IHSS REFERENCE NUMBER

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

SED-17 EXISTING SEDIMENT SAMPLE LOCATION

DIRT ROAD

PROPOSED LOCATIONS FOR SEDIMENT SAMPLES[1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

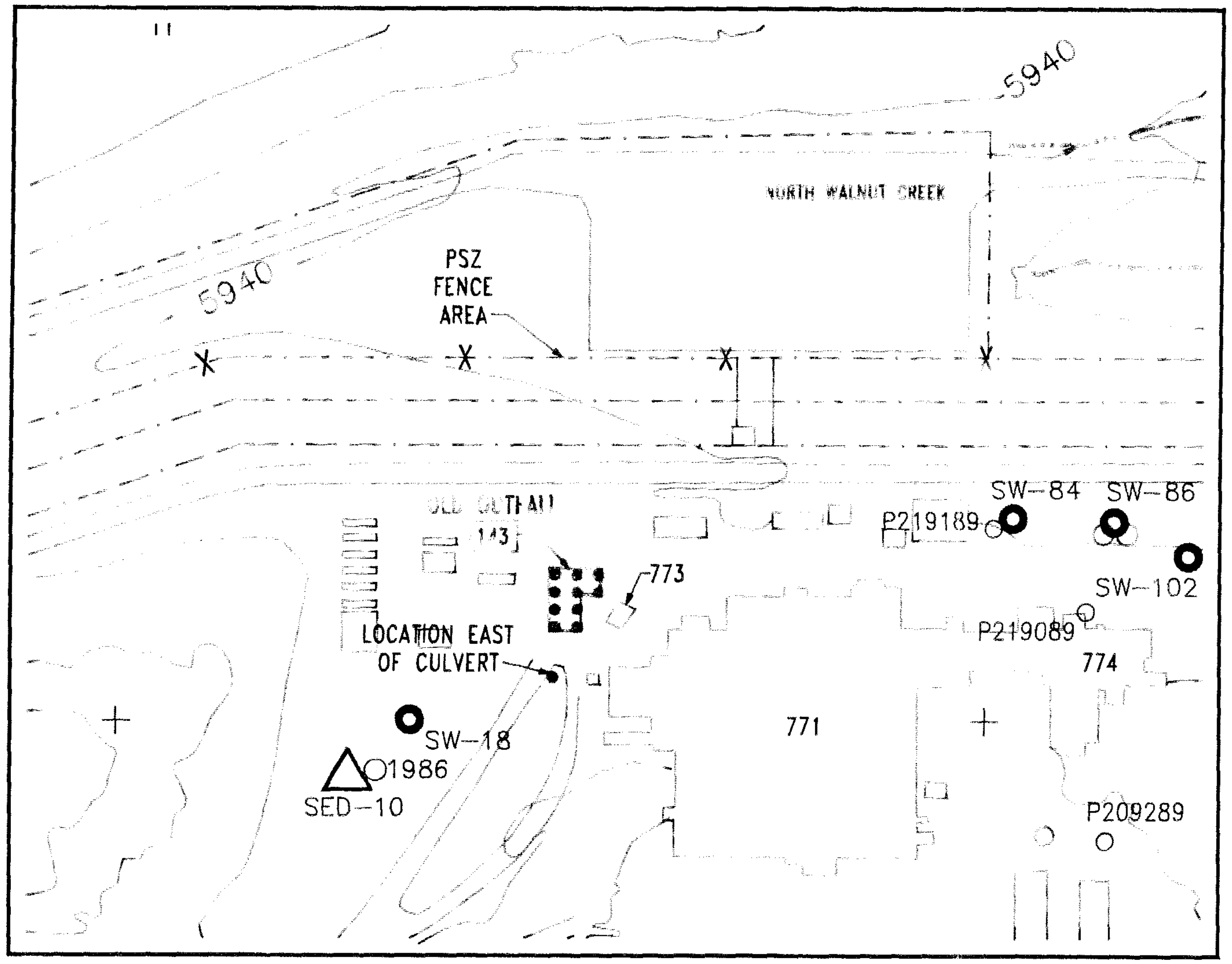
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES AND SITE-WIDE PROGRAM BEDROCK WELLS ON NORTH AND SOUTH WALNUT CREEKS

FIGURE 7-4 (2 OF 2) APRIL 1991

DRAFT

[redacted]



N

0 100 200

SCALE: 1" = 200'

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 EXISTING SEDIMENT SAMPLING LOCATION
- INTERMITTENT STREAM
- DIRT ROAD
- 968 ROCKY FLATS BLDG. NO.
- PROPOSED SOIL BORING LOCATION[1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

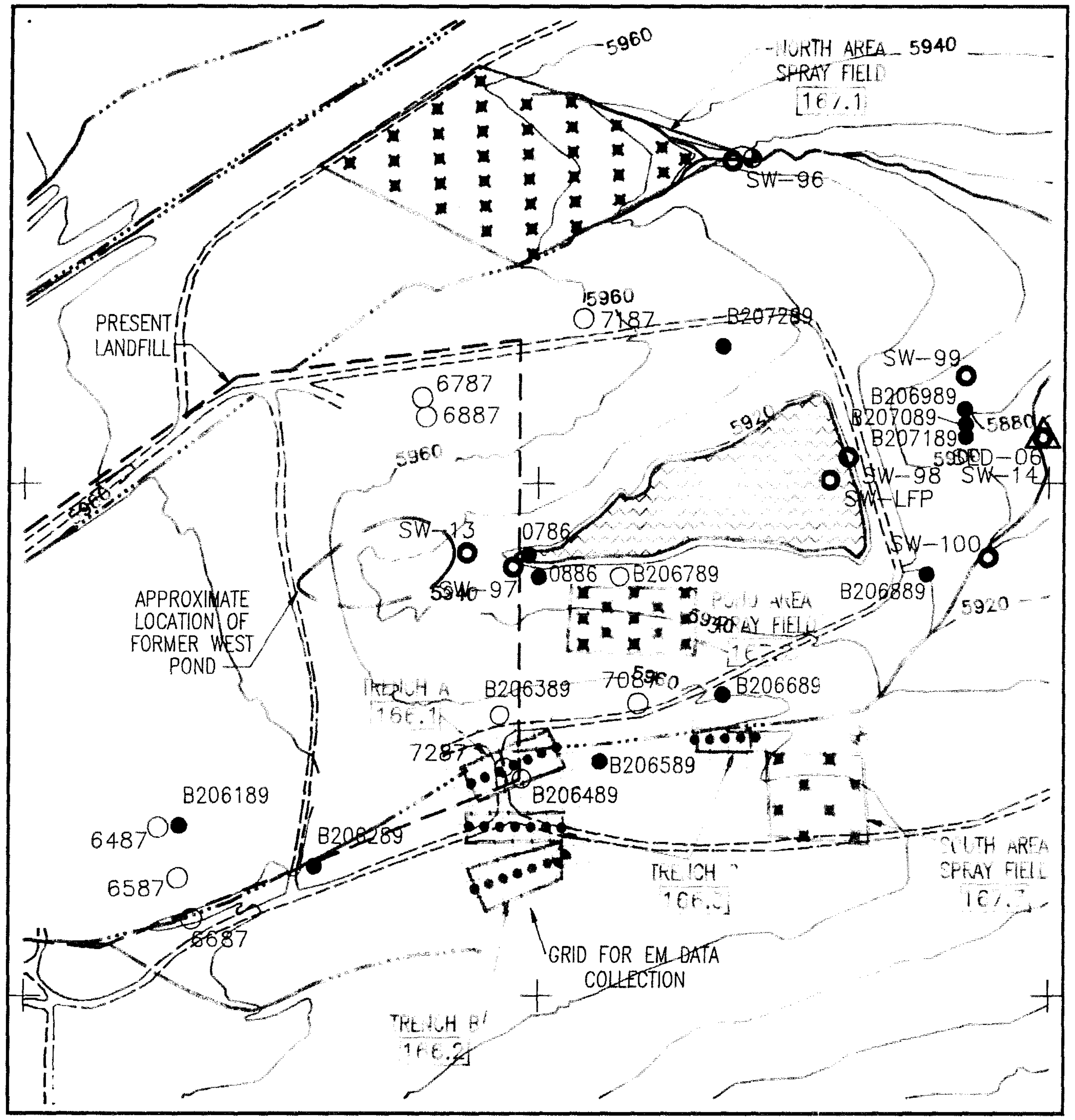
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING LOCATIONS
IHSS 143 OLD OUTFALL AREA

FIGURE 7-5 APRIL 1991

DRAFT

[redacted]



N

0 150 300

SCALE: 1" = 300'

EXPLANATION

IHSS	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
3087	EXISTING BEDROCK GROUNDWATER MONITORING WELL
	INTERMITTENT STREAM
	DIRT ROAD
	PROPOSED SOIL BORING LOCATION [1]
	PROPOSED WELL LOCATION [1]
	PROPOSED BORING AND SURFACE SAMPLE LOCATION [1]
	PROPOSED ELECTROMAGNETIC SURVEY LINE LOCATION [1]

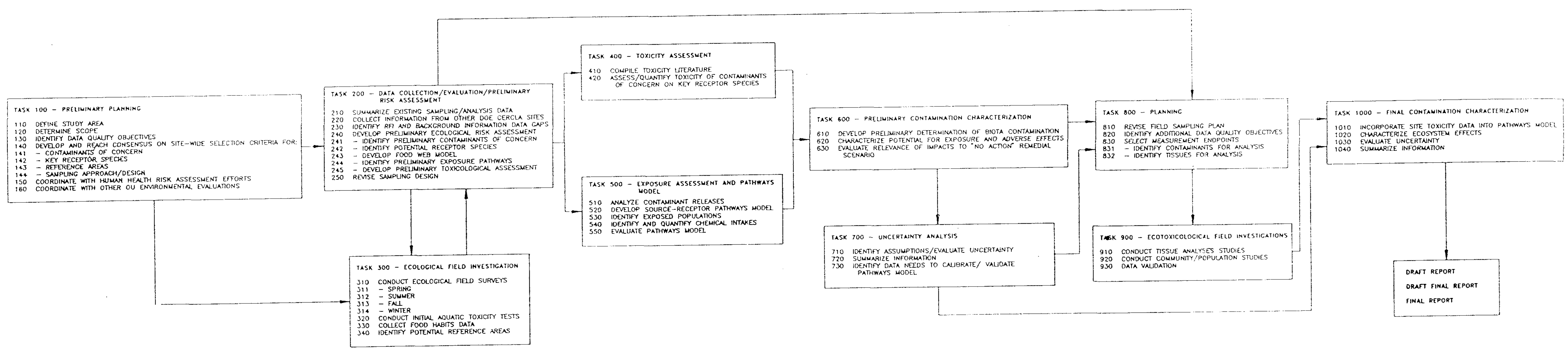
[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS IHSSs 166.1-3, TRENCHES A, B, & C IHSSs 167.1-3 NORTH AREA, POND AREA AND SOUTH AREA

FIGURE 7-6 APRIL 1991



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FOR COMMENTS & DISCUSSION ONLY

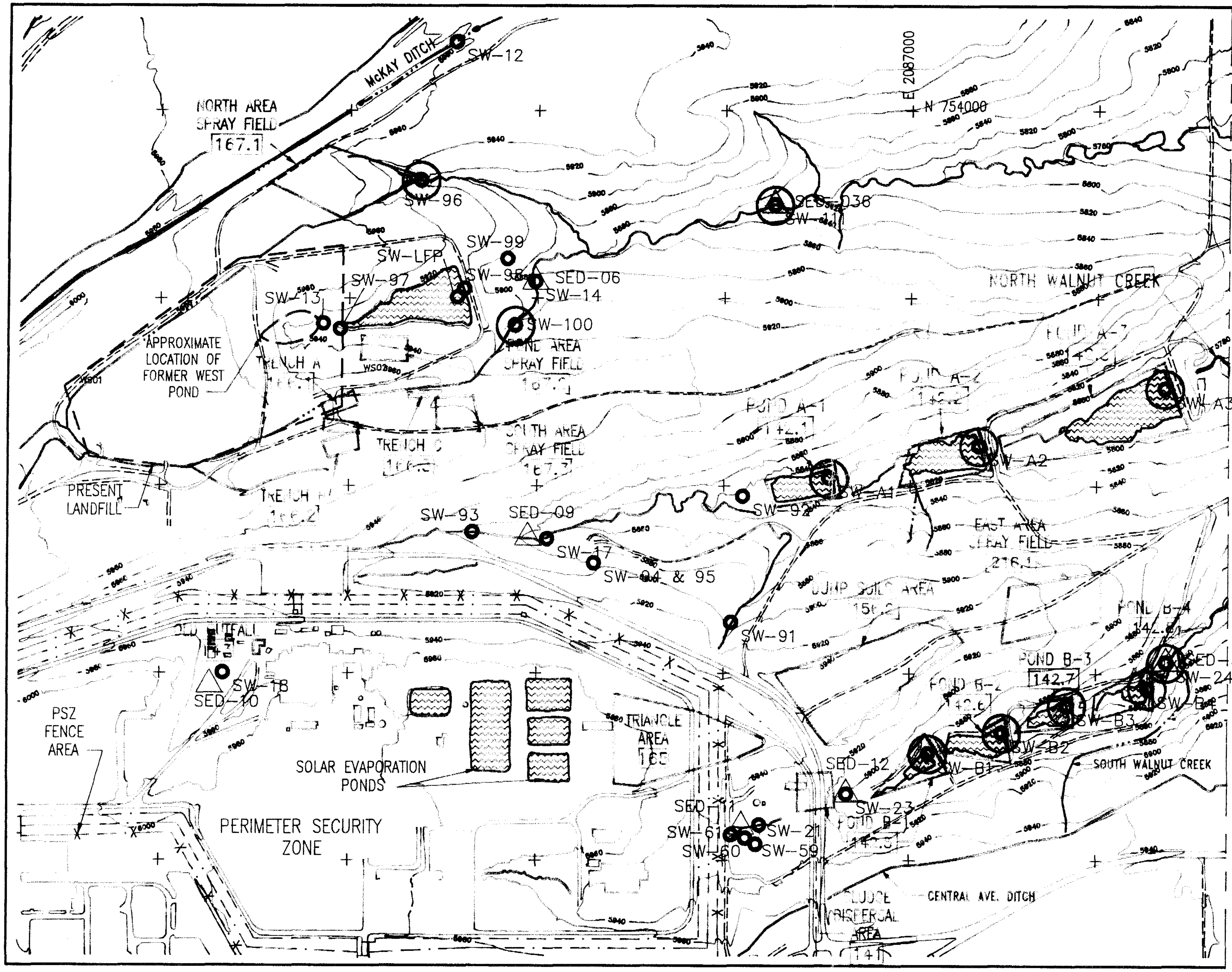
[redacted]

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

FLOW DIAGRAM:
INTERRELATIONSHIPS BETWEEN TASKS

FIGURE 9-1 APRIL 1991



EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6
- IHSS REFERENCE NUMBER
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- SED-17 EXISTING SEDIMENT SAMPLE LOCATION
- PERIMETER SECURITY ZONE
- DIRT ROAD
- SAMPLING LOCATION FOR AQUATIC BIOTA [1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

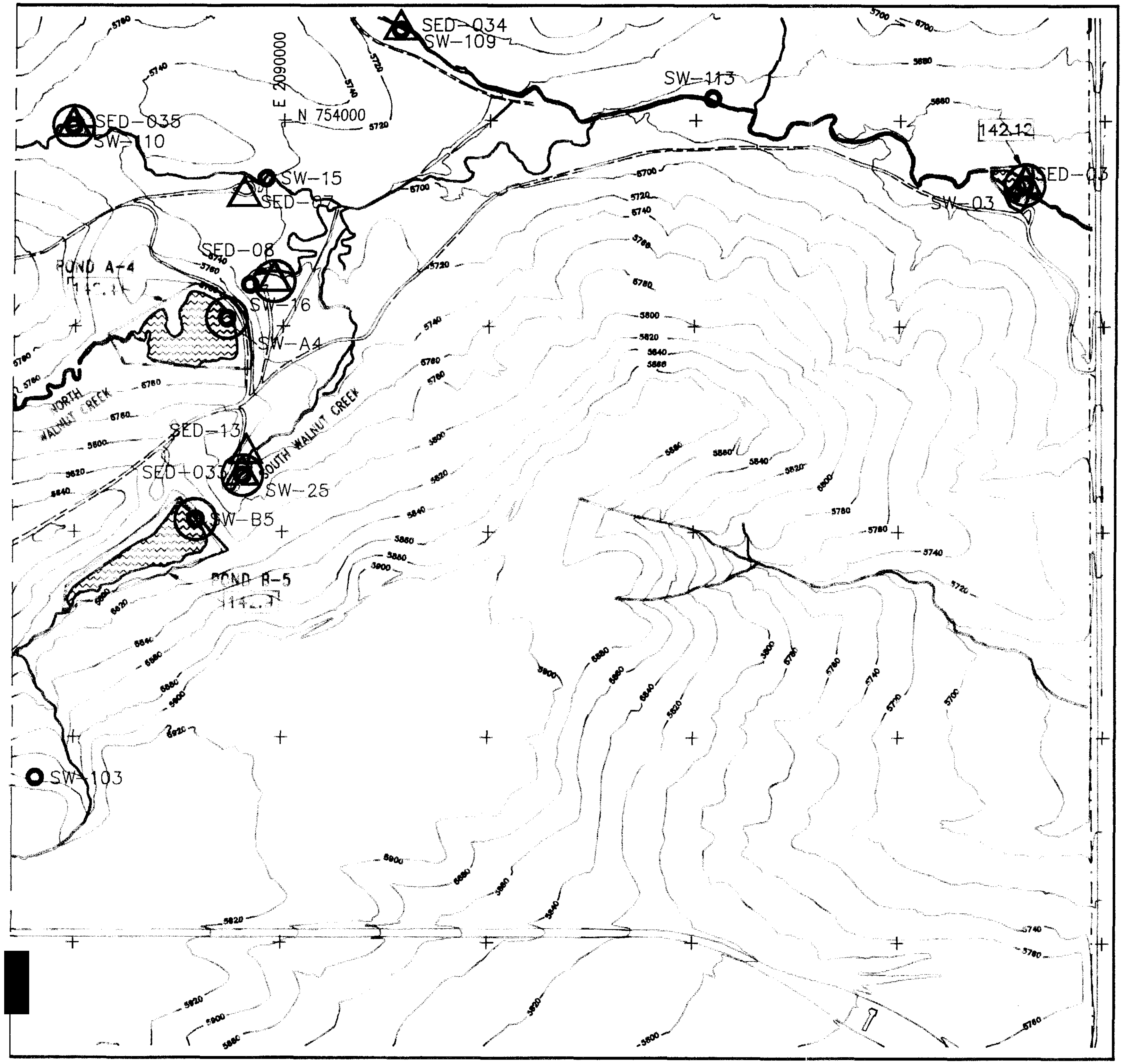
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND AQUATIC SAMPLING LOCATIONS

FIGURE 9-3 (1 OF 2) APRIL 1991

[redacted]

MATCHLINE
(SEE FIGURE 7-4 [2 OF 2])



N

0 300 600
SCALE: 1" = 600'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

115 IHSS REFERENCE NUMBER

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

SED-17 EXISTING SEDIMENT SAMPLE LOCATION

DIRT ROAD

SAMPLING LOCATION FOR AQUATIC [redacted]

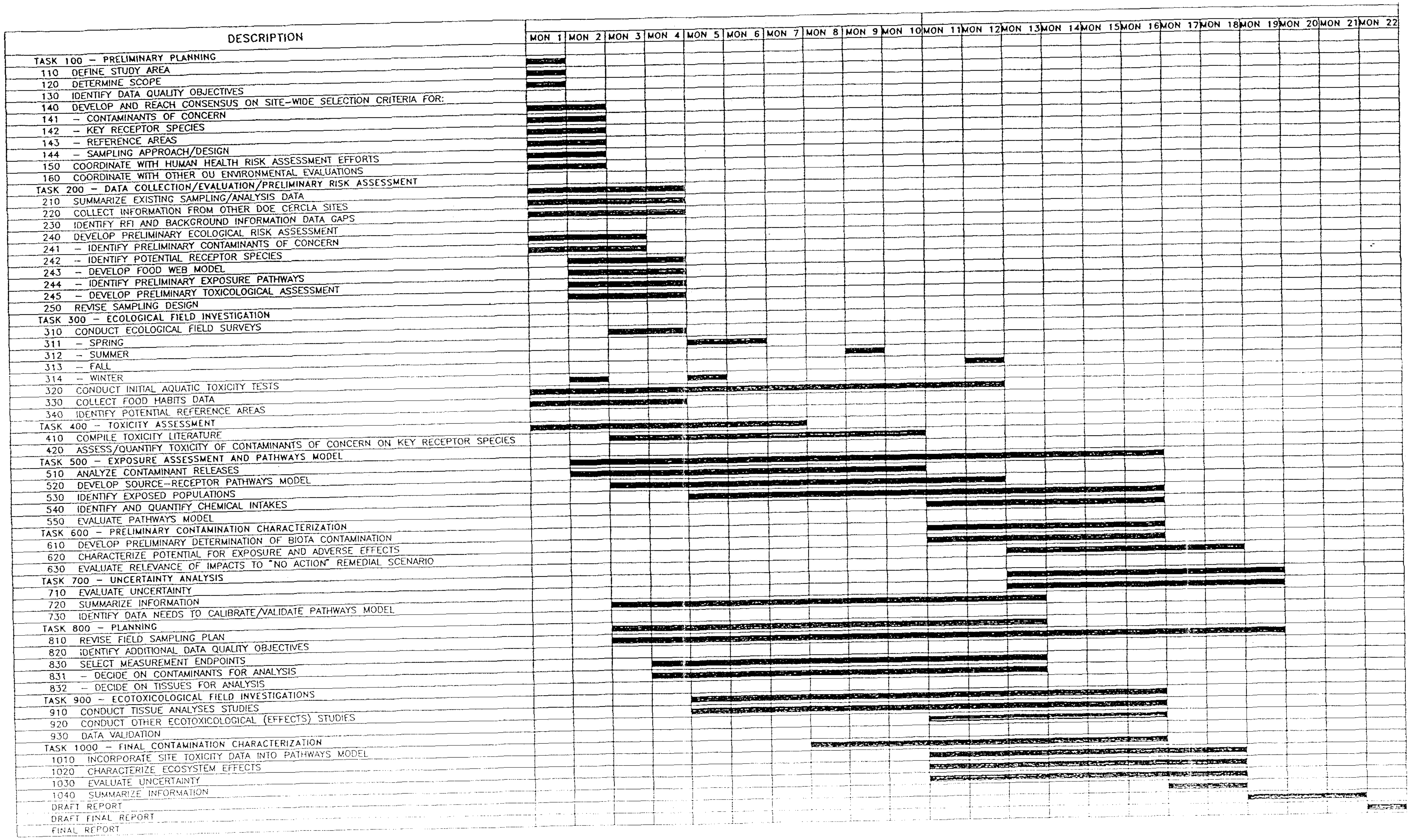
[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES A[redacted] AQUATIC SAMPLING LOCATIONS

FIGURE 9-3 (2 OF 2) APRIL [redacted]



[redacted]

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

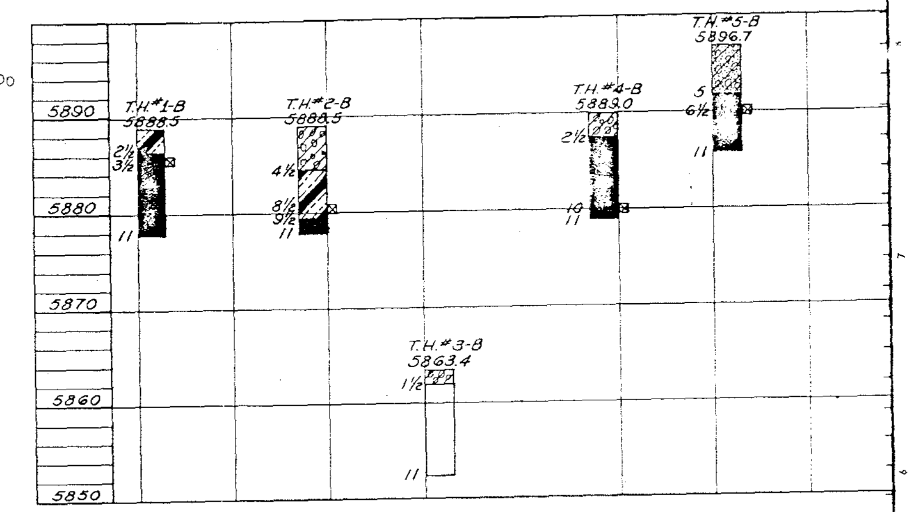
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

NORTH & SOUTH WALNUT CREEKS
DRAINAGE ENVIRONMENTAL EVALUATION
ACTIVITY SCHEDULE

FIGURE 9–4 APRIL 1991

B.M. #1: 16 PENNY SPIKE IN CORNER POST OF "T" FENCE EAST APPROX. 10' NORTH OF NE CORNER SECTION #2 ELEV. 5784.65

B.M. #2: WEST CORNER CONCRETE DROP INLET PICTURE POINT V-18 @ S-E CORNER RESERVOIR A-2 ELEV. 5817.55

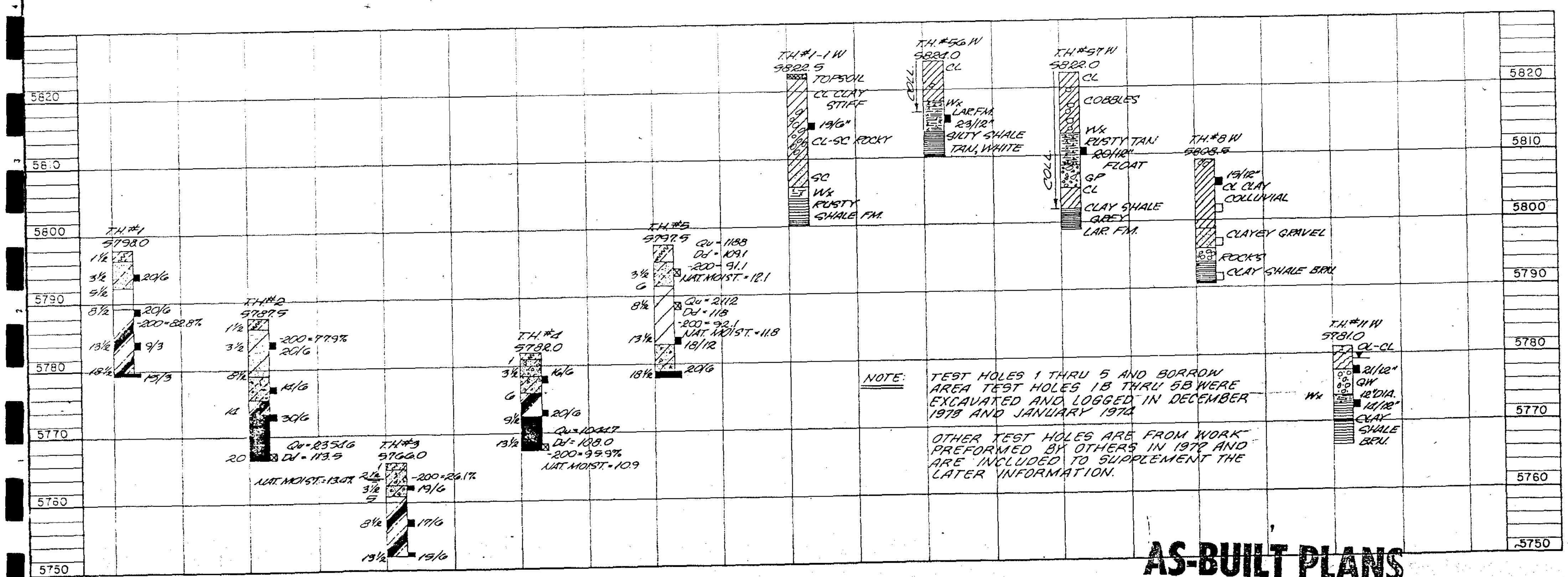


BORROW AREA TEST HOLES

[redacted]

LEGEND & SYMOLS

- BLACK TO BROWN SANDY SILT-ORGANIC
- BLACK TO BROWN SANDY SILT
- SILTY SAND & GRAVEL
- CLAYEY SAND & GRAVEL
- BROWN TO GREY SILTY CLAY
- GREY WEATHERED CLAYSTONE-OCCASIONAL SANDSTONE LENSES
- LIGHT BROWN TO YELLOW WEATHERED SANDSTONE
- GREY CLAYSTONE BEDROCK
- SILTY CLAY WITH LARGE COBBLES & ORGANIC MATTER
- SANDY CLAY WITH COBBLES & HEAVY ORGANIC MATTER
- STANDARD PENETRATION TEST
- SHELBY TUBE SAMPLE
- DEPTH OF GROUND WATER
- Qu UNCONFINED COMP. STRENGTH
- Dd UNIT DRY WT.-LB/FT
- -200 % PASSING A #200 SIEVE



NOTE: TEST HOLES 1 THRU 5 AND BORROW AREA TEST HOLES 1B THRU 5B WERE EXCAVATED AND LOGGED IN DECEMBER 1973 AND JANUARY 1974.

OTHER TEST HOLES ARE FROM WORK PREFORMED BY OTHERS IN 1972 AND ARE INCLUDED TO SUPPLEMENT THE LATER INFORMATION.

AS-BUILT PLANS

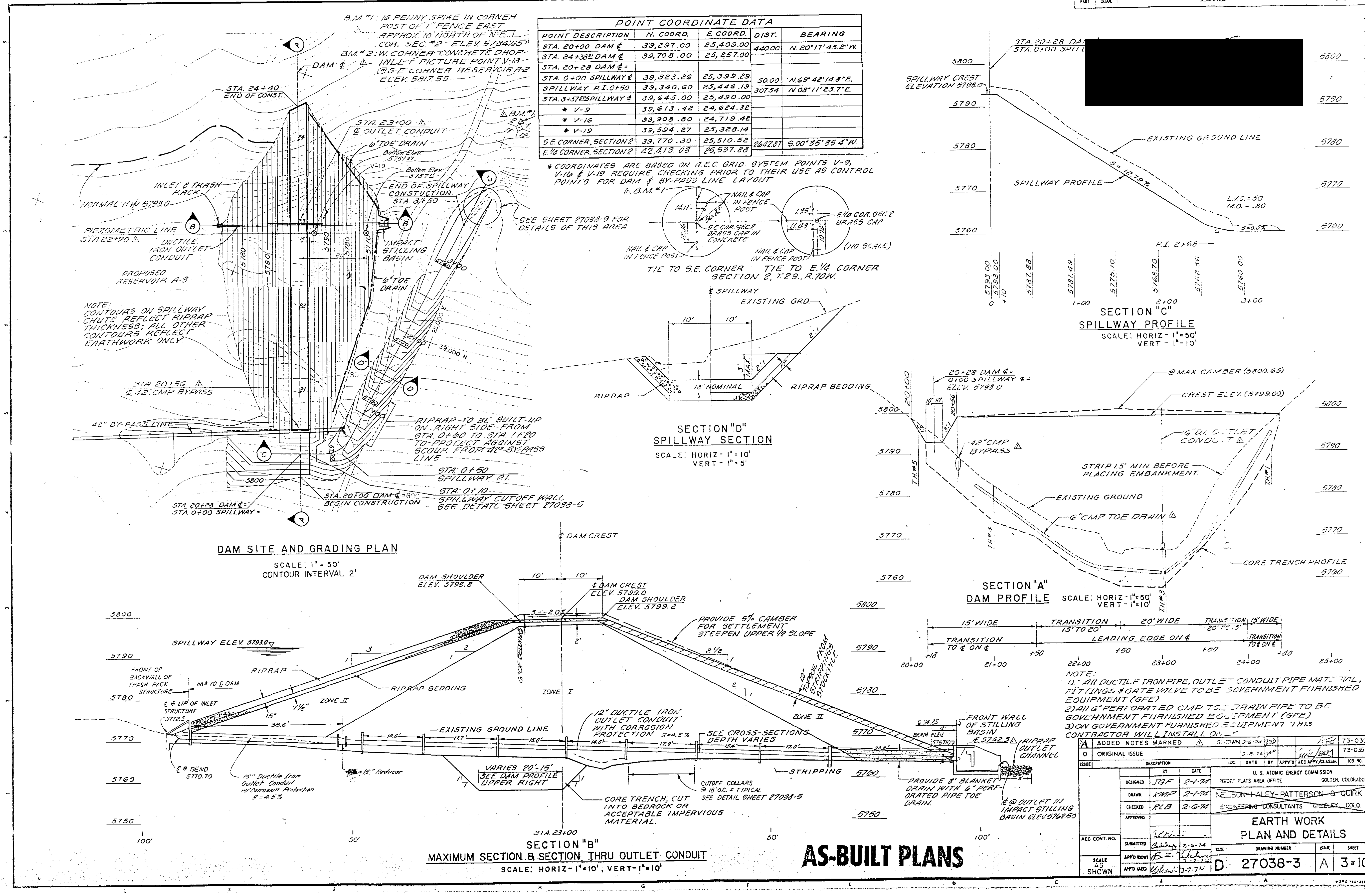
ISSUE	DESCRIPTION	LOC.	DATE	BY	APP'D	AEC APPV./CLASSIF.	JOB NO.
A	ADDED NOTES MARKED △	SHOWN	3-6-74				73-0353
0	ORIGINAL ISSUE		2-8-74				73-0353

	BY	DATE	
DESIGNED	JGF	2-1-74	U. S. ATOMIC ENERGY COMMISSION ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
DRAWN	KMP	2-1-74	~~NELSON-HALEY-PATTERSON & QUIRK~~
CHECKED	RLB	2-6-74	~~ENGINEERING CONSULTANTS GREELEY, COLO.~~
APPROVED		2-7-74	LOCATION MAP AND LOG OF BORINGS
SUBMITTED		2-6-74	
APP'D (DOW)			
APP'D (AEC)		2-7-74	

AEC CONT. NO.

SCALE 1" = 100' HOR. 1" = 10' VERT.

SIZE D | DRAWING NUMBER 27038-2 | ISSUE A | SHEET 2 of 10



POINT COORDINATE DATA

POINT DESCRIPTION	N. COORD.	E. COORD.	DIST.	BEARING
STA. 20+00 DAM ℄	39,297.00	25,409.00	440.00	N.20°17'45.2"W.
STA. 24+38.21 DAM ℄	39,708.00	25,257.00		
STA. 20+28 DAM ℄ =				
STA. 0+00 SPILLWAY ℄	39,323.26	25,399.29	50.00	N.69°42'14.8"E.
SPILLWAY P.I. 0+50	39,340.60	25,446.19	307.54	N.08°11'23.7"E.
STA. 3+57.55 SPILLWAY ℄	39,645.00	25,490.00		
* V-9	39,613.42	24,624.32		
* V-16	38,908.80	24,719.42		
* V-19	39,594.27	25,328.14		
S.E. CORNER, SECTION 2	39,770.30	25,510.52	2642.81	S.00°35'35.4"W.
E.1/4 CORNER, SECTION 2	42,413.03	25,537.88		

* COORDINATES ARE BASED ON A.E.C. GRID SYSTEM. POINTS V-9, V-16 & V-19 REQUIRE CHECKING PRIOR TO THEIR USE AS CONTROL POINTS FOR DAM & BY-PASS LINE LAYOUT

NOTE:
1) ALL DUCTILE IRON PIPE, OUTLET CONDUIT PIPE MATERIAL, FITTINGS & GATE VALVE TO BE GOVERNMENT FURNISHED EQUIPMENT (GFE)
2) ALL 6" PERFORATED CMP TOE DRAIN PIPE TO BE GOVERNMENT FURNISHED EQUIPMENT (GFE)
3) ON GOVERNMENT FURNISHED EQUIPMENT THIS CONTRACTOR WILL INSTALL ON...

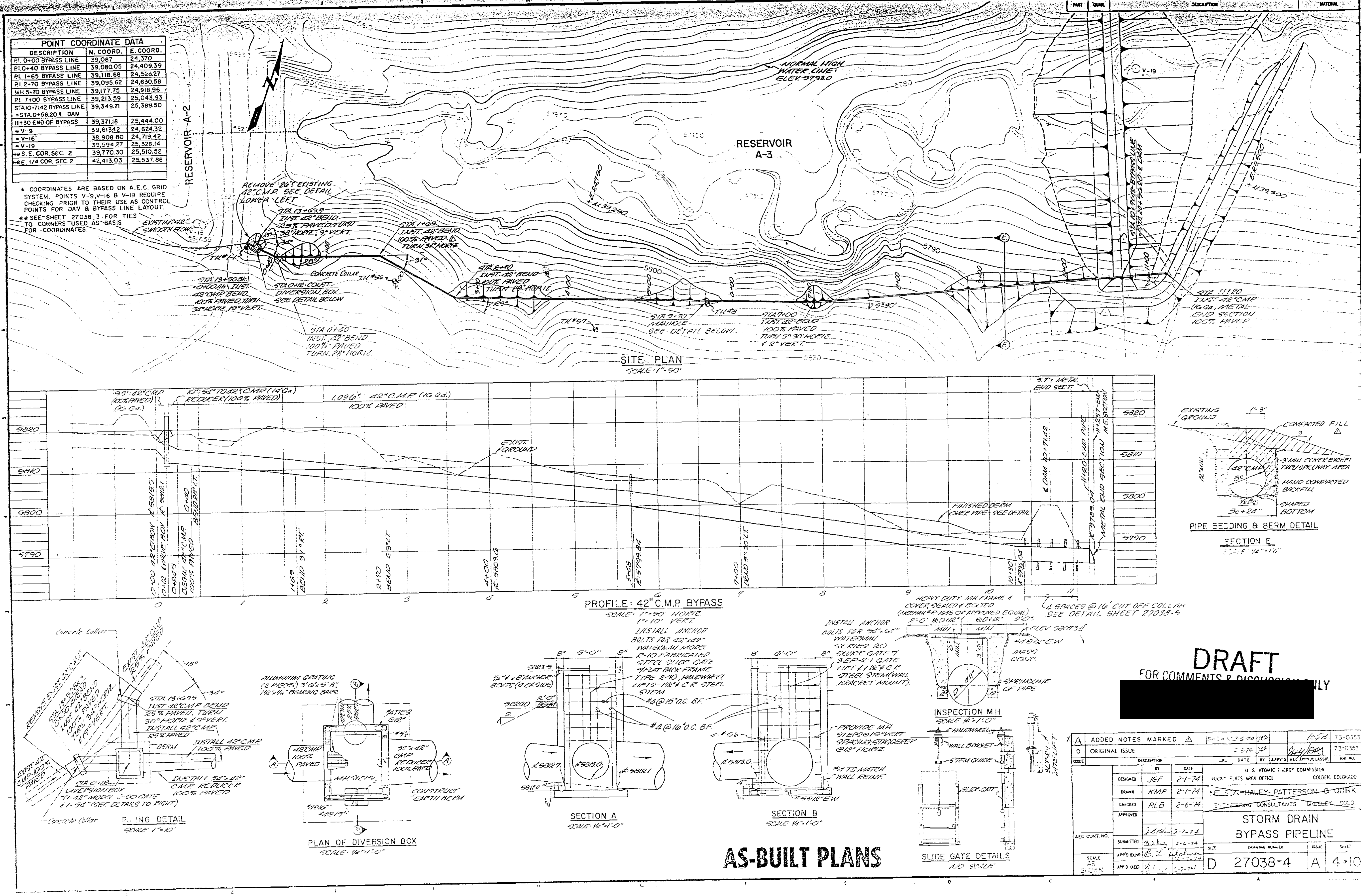
ISSUE	DESCRIPTION		DATE	BY	APPV'D	JOB NO.
A	ADDED NOTES MARKED △		2-6-74			73-0353
0	ORIGINAL ISSUE		2-8-74			73-0353

	BY	DATE
DESIGNED	JGF	2-1-74
DRAWN	KMP	2-1-74
CHECKED	RLB	2-6-74
SUBMITTED		2-6-74
APP'D		2-7-74

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
NELSON-HALEY-PATTERSON & QUIRK
ENGINEERING CONSULTANTS GREELEY, COLO.

EARTH WORK
PLAN AND DETAILS

SCALE AS SHOWN | SIZE D | DRAWING NUMBER 27038-3 | ISSUE A | SHEET 3 of 10



POINT COORDINATE DATA		
DESCRIPTION	N. COORD.	E. COORD.
P.I. 0+00 BYPASS LINE	39,087	24,370
P.I. 0+40 BYPASS LINE	39,080.05	24,409.39
P.I. 1+65 BYPASS LINE	39,118.68	24,528.27
P.I. 2+70 BYPASS LINE	39,095.62	24,630.58
M.H. 5+70 BYPASS LINE	39,177.75	24,918.96
P.I. 7+00 BYPASS LINE	39,213.59	25,043.93
STA.10+71.42 BYPASS LINE =STA.0+56.20 ℄ DAM	39,349.71	25,389.50
11+30 END OF BYPASS	39,371.18	25,444.00
* V-9	39,613.42	24,624.32
* V-16	38,908.80	24,719.42
* V-19	39,594.27	25,328.14
** S.E. COR. SEC. 2	39,770.30	25,510.52
** E. 1/4 COR. SEC. 2	42,413.03	25,537.88

* COORDINATES ARE BASED ON A.E.C. GRID SYSTEM. POINTS V-9, V-16 & V-19 REQUIRE CHECKING PRIOR TO THEIR USE AS CONTROL POINTS FOR DAM & BYPASS LINE LAYOUT.

** SEE SHEET 27038-3 FOR TIES TO CORNERS USED AS BASIS FOR COORDINATES.

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FOR COMMENTS & DISCUSSION ONLY
[redacted]

ISSUE	DESCRIPTION	DATE	BY	APP'D	AEC APP'Y/CLASSIF.	JOB NO.
A	ADDED NOTES MARKED △					73-0353
0	ORIGINAL ISSUE	2-6-74				73-0353

	BY	DATE
DESIGNED	JGF	2-1-74
DRAWN	KMP	2-1-74
CHECKED	RLB	2-6-74
APPROVED		2-7-74
SUBMITTED		2-6-74
APP'D (DOW)	B. L.	
APP'D (AEC)		3-7-74

AEC CONT. NO.

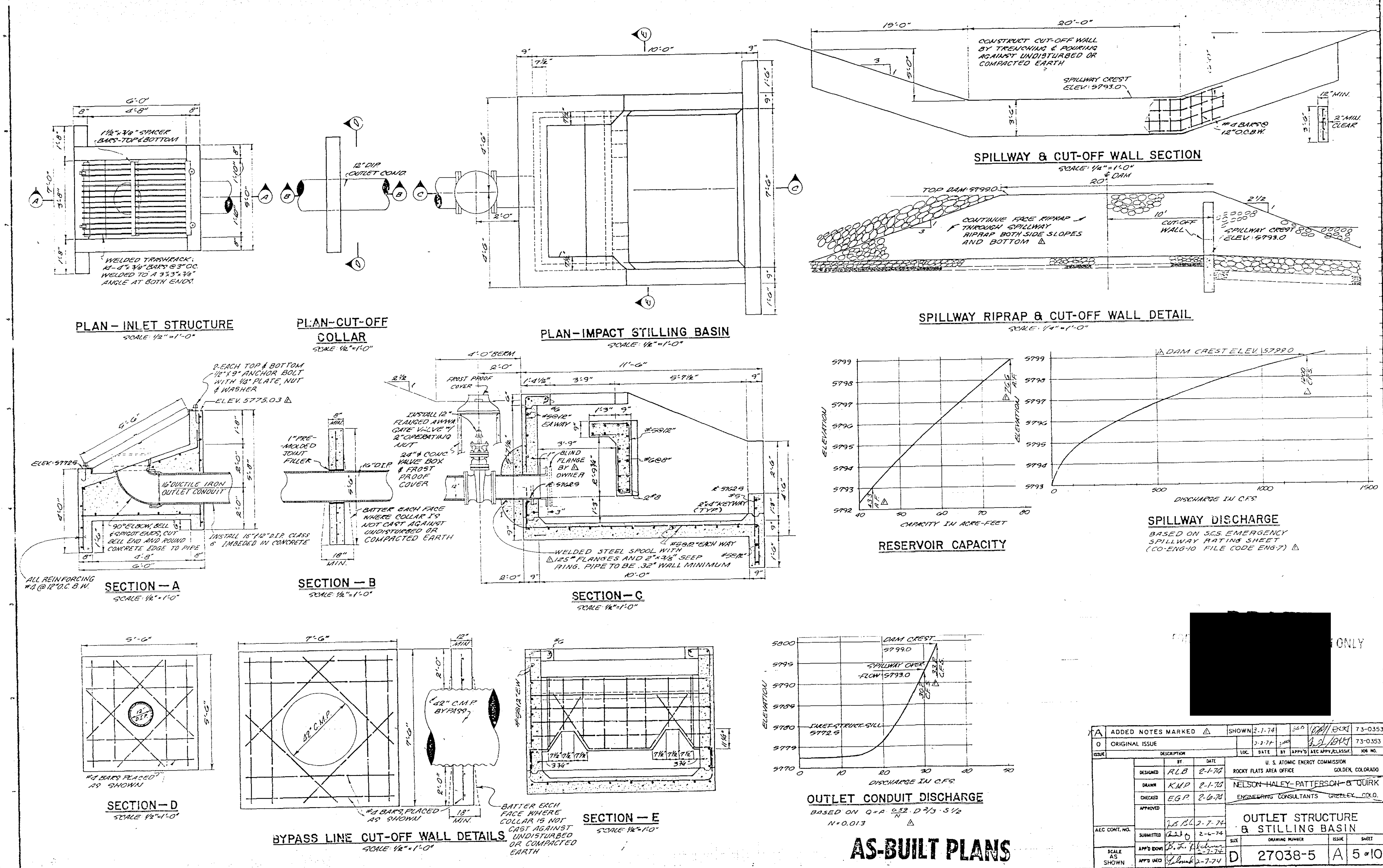
SCALE AS SHOWN

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO

~~NELSON-HALEY-PATTERSON & QUIRK ENGINEERING CONSULTANTS GREELEY, COLO.~~

STORM DRAIN
BYPASS PIPELINE

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	27038-4	A	4 of 10



[redacted]

A	ADDED NOTES MARKED △	SHOWN 2-7-74			73-0353
0	ORIGINAL ISSUE	2-7-74			73-0353
ISSUE	DESCRIPTION	LOC.	DATE	BY / APP'D / AEC APP'V/CLASSIF.	JOB NO.

U. S. ATOMIC ENERGY COMMISSION
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO

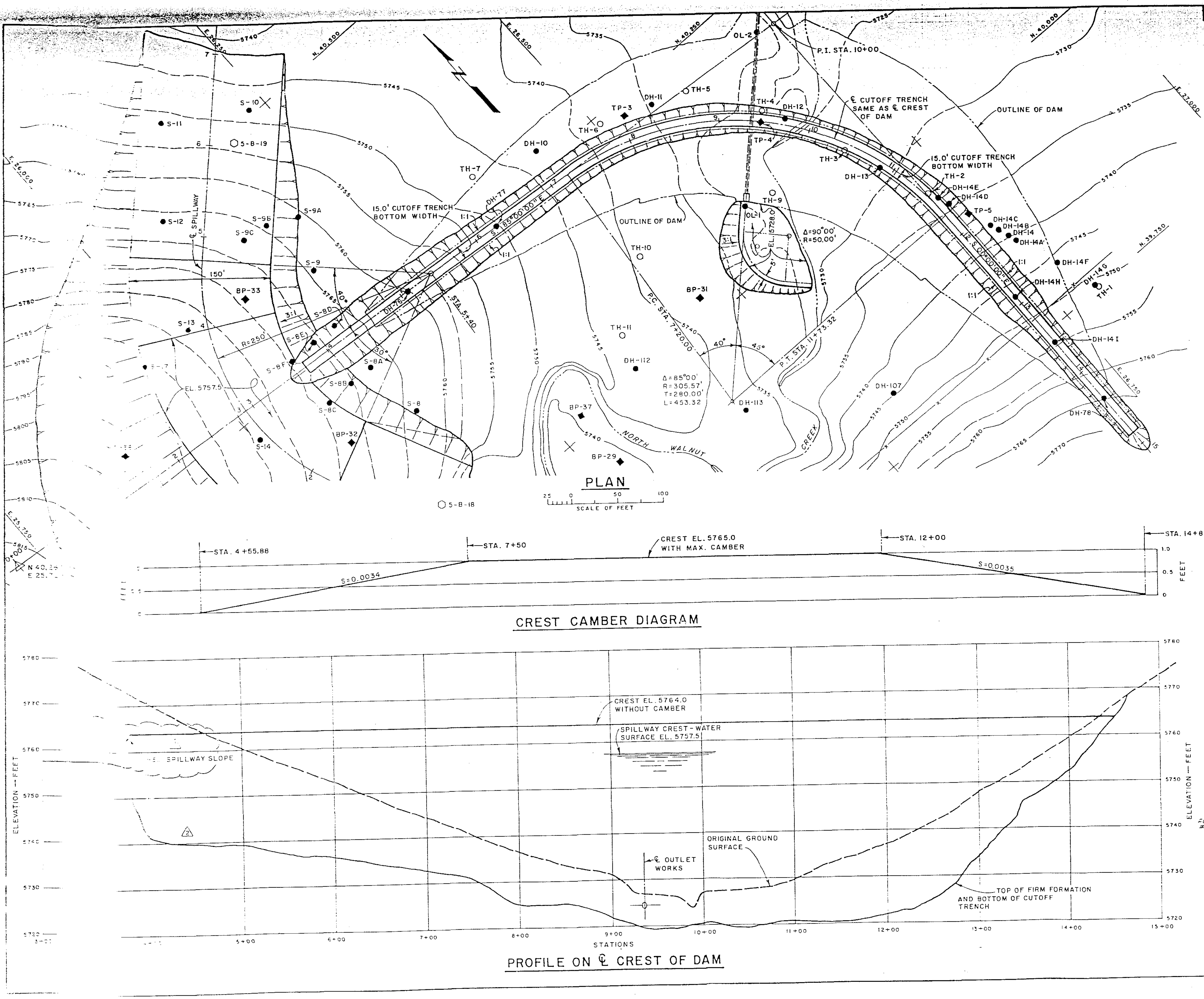
NELSON-HALEY-PATTERSON-& QUIRK
ENGINEERING CONSULTANTS — GREELEY, COLO.

	BY	DATE
DESIGNED	RLB	2-1-74
DRAWN	KMP	2-1-74
CHECKED	EGP	2-6-74
APPROVED		2-7-74
SUBMITTED		2-6-74
APP'D (OWN)		2-7-74
APP'D (AEC)		2-7-74

AEC CONT. NO.

OUTLET STRUCTURE & STILLING BASIN

SCALE	SIZE	DRAWING NUMBER	ISSUE	SHEET
AS SHOWN	D	27038-5	A	5 of 10



[redacted]

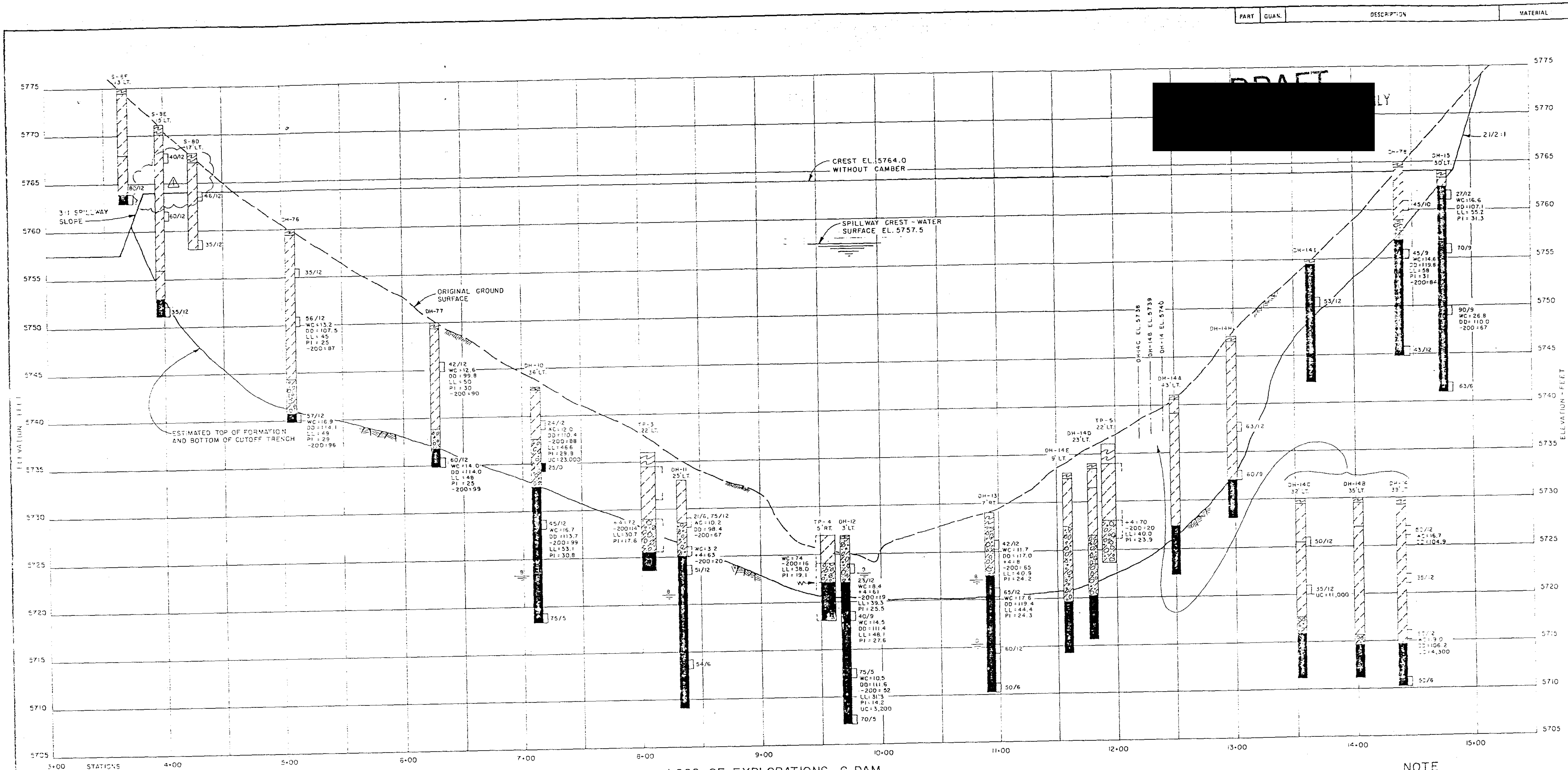
PART	QUAN.	DESCRIPTION		MATERIAL

ISSUE	DESCRIPTION	DATE		
A	AS BUILT	11-20-79		389001
1	CHANGED LEFT ABUTMENT	11-16-78		389001
0	ORIGINAL ISSUE	10-17-78		389001

	BY	DATE
DESIGNED	MJD	8-2-78
DRAWN	R.E.C.	8-4-78
CHECKED	O.J.	9-15-78
APPROVED		
SUBMITTED		9-20-78
APPROVED		10-17-78
APPROVED DOE		

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE — GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT — GOLDEN, COLORADO 80401
SURFACE WATER CONTROL
A-4 DAM-CUTOFF TRENCH PLAN AND DAM PROFILE

SIZE D | DRAWING NUMBER 27165 - 212 | ISSUE A | SHEET 6
SCALE 1"=50'



LOGS OF EXPLORATIONS - ℄ DAM

NOTE

1. SEE DRAWINGS 27165-211 AND 27165-240 FOR LOCATION OF EXPLORATIONS.

LEGEND:

- Topsoil, clay, also some peat material, organic.
- Clay (CL), sandy, with some gravel, occasionally calcareous, very stiff, slightly moist to moist, light to dark brown.
- Gravel (GC), clayey, with a small amount of sand, medium amount of cobbles; dense to very dense, slightly moist, brown.
- Displaced claystone (landslide deposit), medium hard, moist, brown; Also contains some gravel, clay and sandstone.
- Weathered claystone, firm, moist, gray, tan and brown.
- Claystone bedrock, some sandy and sandstone lenses, firm to very hard (generally increasing hardness, strength with depth), moist, generally light gray to gray and tan to brown.
- Undisturbed drive sample. The symbol 24/12 indicates that 24 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.
- Disturbed standard split spoon sample.

- Bucket sample
- 0.8 Depth to free water and number of days after drilling measurement was taken.
- Water seeping at indicated depth at time of pit excavation.

WC = Water Content (%);
DD = Dry Density (pcf);
LL = Liquid Limit (%);
PI = Plasticity Index (%);
+4 = Percent Larger than #4 Screen;
-200 = Percent Passing No. 200 Sieve;

UC = Unconfined Compressive Strength (psf).
LT. = LEFT
RT. = RIGHT

FCO #1

ISSUE	DESCRIPTION	DATE				DOE	CLASS	JOB NO.
A	AS BUILT	11-12-80	AW					389001
1	CHANGED LEFT ABUTMENT	11-16-79	MSD			RLF		389001
0	ORIGINAL ISSUE	10-17-78						389001

TOLERANCES		BY	DATE
FRACT. ±	DESIGNED	MLD	8-3-78
ANGLE ±	DRAWN	H.E.W.	8-4-78
DEC. ±	CHECKED	A.J.	9-15-78
UNLESS NOTED OTHERWISE	APPROVED		
REMOVE BURRS AND SHARP EDGES			
NEXT ASSEMBLY			
DOE CONT. NO.	SUBMITTED		9-20-78
	APPROVED AI		10-17-78
SCALE AS SHOWN	APPROVED DOE		10/17/78

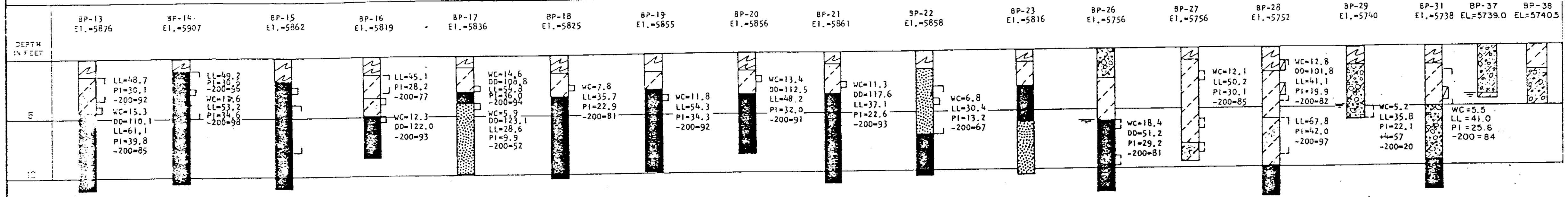
U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO

ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO 80401

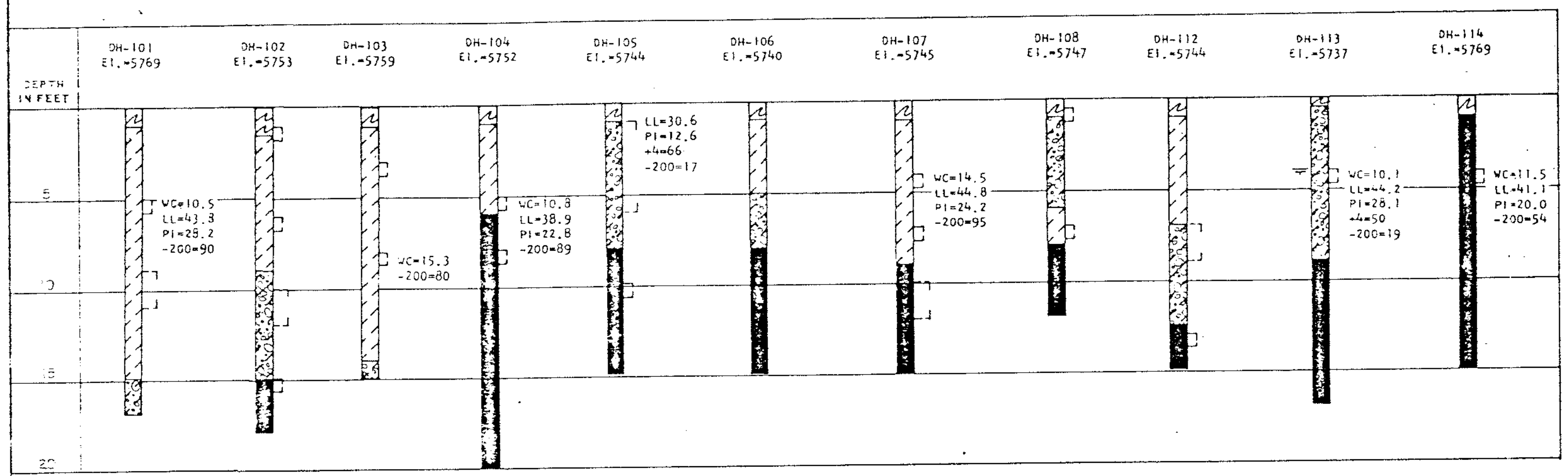
SURFACE WATER CONTROL
A-4 DAM
LOGS OF EXPLORATIONS
DAM PROFILE

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	27165- 213	A	7 OF

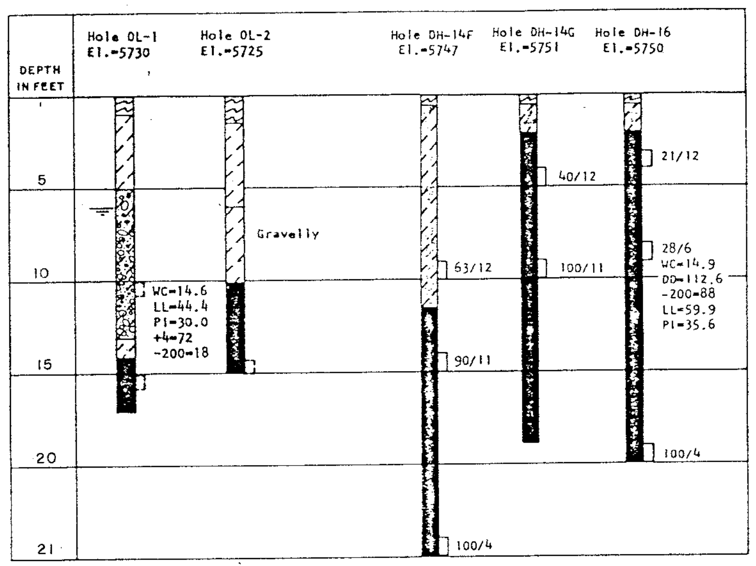
PART	QUAN.	DESCRIPTION	MATERIAL



BORROW EXPLORATIONS



BORROW EXPLORATIONS



OUTLET WORKS EXPLORATIONS

EXPLORATIONS ADJACENT TO ℄ DAM

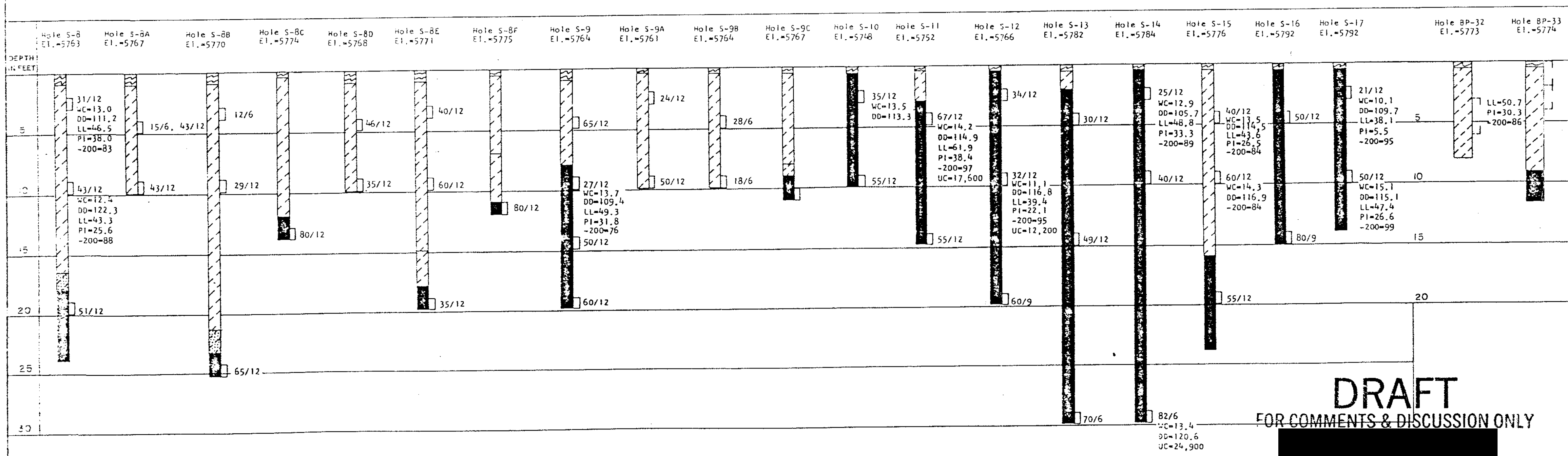
LEGEND

- Topsoil, clay, sandy to gravelly, dark brown, roots in upper few inches.
- Clay (CL), slightly sandy to sandy, scattered gravel, very stiff to stiff, slightly moist, brown.
- Gravel, Clayey (GC), small to large amounts of sand, scattered to medium amount of cobbles, dense to very dense, brownish.
- Weathered Claystone (CL-CH), firm, moderately high to high plasticity, moist, light brown to gray.
- Sandstone Bedrock, fine-grained, medium hard to hard, slightly moist, light brown.
- Claystone Bedrock, some sandstone, medium hard to very hard, moist, generally high plasticity, gray with some brown.
- Displaced Claystone (landslide deposit), medium hard, moist, brown.
- Undisturbed drive sample. The symbol 63/12 indicates that 63 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.
- Undisturbed hand driven sample.
- Auger sample (disturbed).
- Disturbed large quantity (20 to 50 lbs.) sample.
- Depth to free water at time of excavation or drilling.

WC = Water Content (%); PI = Plasticity Index (%);
DD = Dry Density (pcf); +4 = Percent Larger Than #4 Screen;
LL = Liquid Limit (%); -200 = Percent Passing No. 200 Sieve.

NOTE

1. SEE DRAWINGS 27165-211 AND 27-55-240 FOR LOCATION OF EXPLORATIONS.



SPILLWAY EXPLORATIONS

DRAFT
FOR COMMENTS & DISCUSSION ONLY

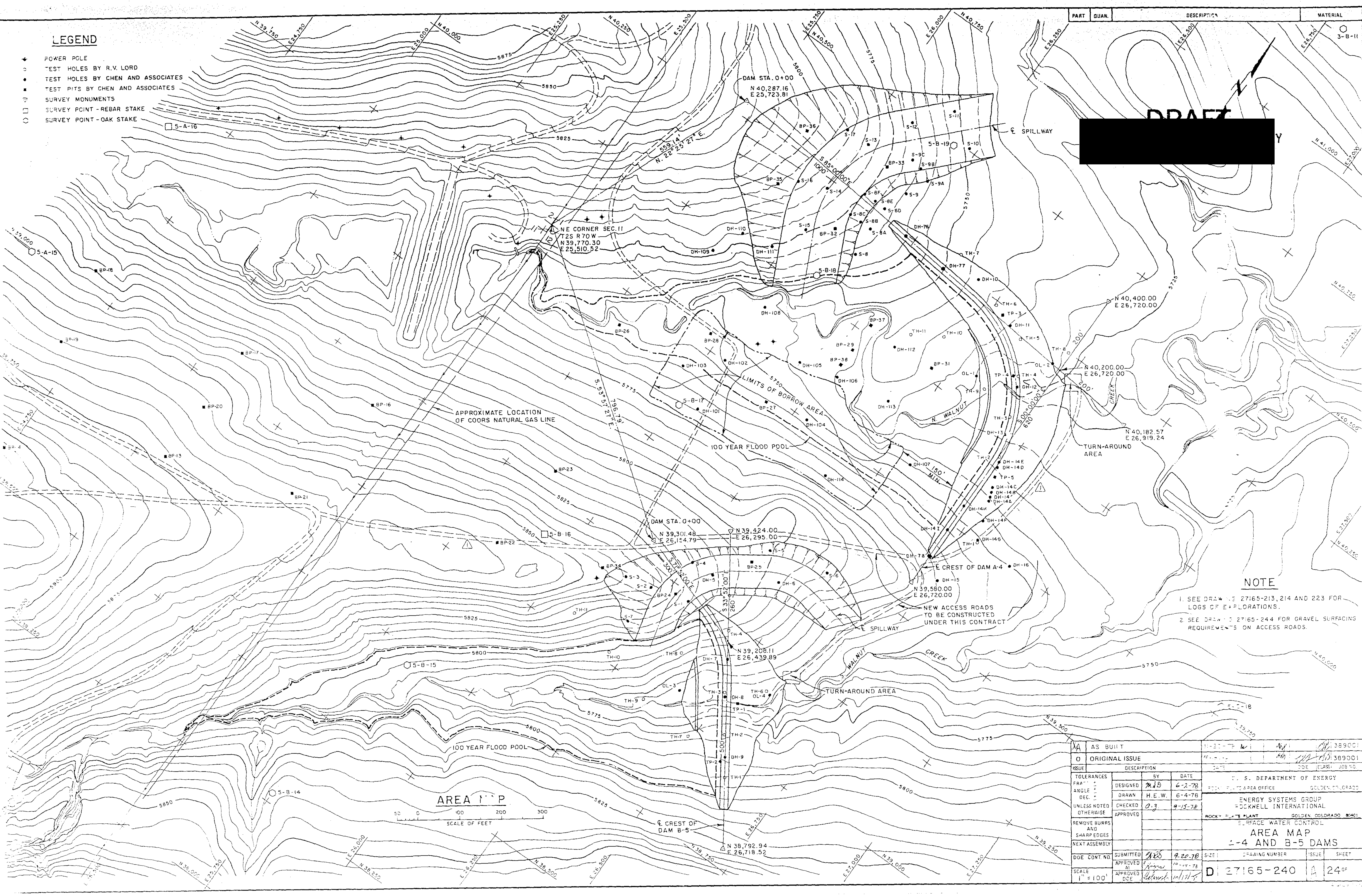
[redacted]

ISSUE	DESCRIPTION	DATE		
A	AS BUILT			389001
O	ORIGINAL ISSUE			389001

		BY	DATE
TOLERANCES FRACT. ± ANGLE ± DEC. ± UNLESS NOTED OTHERWISE	DESIGNED	mLB	8-15-78
	DRAWN	H.E.W.	8-17-78
	CHECKED	a.g.	9-15-78
REMOVE BURRS AND SHARP EDGES	APPROVED		
NEXT ASSEMBLY			
DOE CONT. NO.	SUBMITTED	mLB	9-20-78
SCALE AS SHOWN	APPROVED AI		12-17-73
	APPROVED DOE		

U. S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO 80401
SURFACE WATER CONTROL
A-4 DAM
LOGS OF EXPLORATIONS

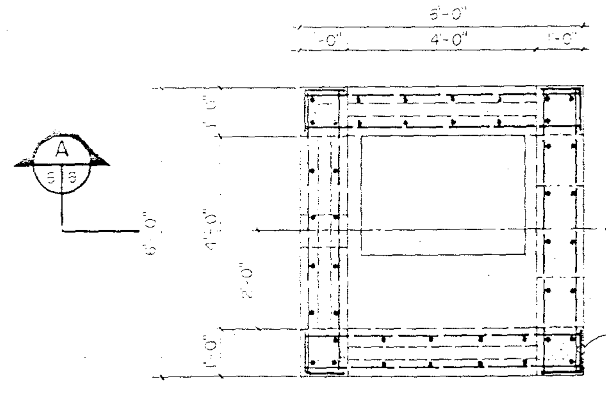
SIZE	DRAWING NUMBER	ISSUE	SHEET
D	27165-214	A	8 OF


LEGEND
POWER POLE
TEST HOLES BY R.V. LORD
TEST HOLES BY CHEN AND ASSOCIATES
TEST PITS BY CHEN AND ASSOCIATES
SURVEY MONUMENTS
SURVEY POINT - REBAR STAKE
SURVEY POINT - OAK STAKE
[redacted]
NOTE
1. SEE DRAW. NO 27165-213, 214 AND 223 FOR LOGS OF EXPLORATIONS.
2. SEE DRAW. NO 27165-244 FOR GRAVEL SURFACING REQUIREMENTS ON ACCESS ROADS.
DAM STA. 0+00
N 40,287.16
E 25,723.81
℄ SPILLWAY
NE CORNER SEC. 11
T2S R70W
N39,770.30
E25,510.52
N 40,400.00
E 26,720.00
N 40,200.00
E 26,720.00
N 40,182.57
E 26,919.24
TURN-AROUND AREA
LIMITS OF BORROW AREA
100 YEAR FLOOD POOL
APPROXIMATE LOCATION OF COORS NATURAL GAS LINE
N 39,424.00
E 26,295.00
DAM STA. 0+00
N 39,301.48
E 26,154.79
℄ CREST OF DAM A-4
N 39,580.00
E 26,720.00
NEW ACCESS ROADS TO BE CONSTRUCTED UNDER THIS CONTRACT
WALNUT CREEK
N 39,208.11
E 26,439.89
℄ CREST OF DAM B-5
N 38,792.94
E 26,718.52
AREA MAP
SCALE OF FEET
AS BUILT
ORIGINAL ISSUE
U. S. DEPARTMENT OF ENERGY
ENERGY SYSTEMS GROUP
ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT GOLDEN, COLORADO
SURFACE WATER CONTROL
AREA MAP
A-4 AND B-5 DAMS
DESIGNED
DRAWN H.E.W. 6-4-78
CHECKED 9-15-78
SUBMITTED 9-20-78
SCALE 1" = 100'
D 27165-240

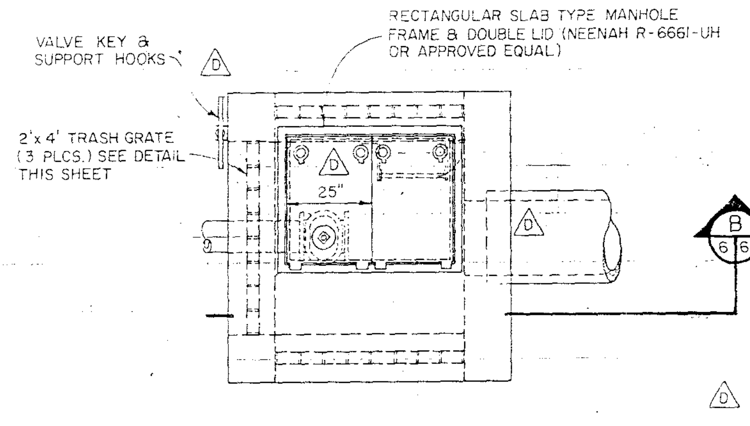
PART	QUAN	DESCRIPTION	MATERIAL

NOTES:

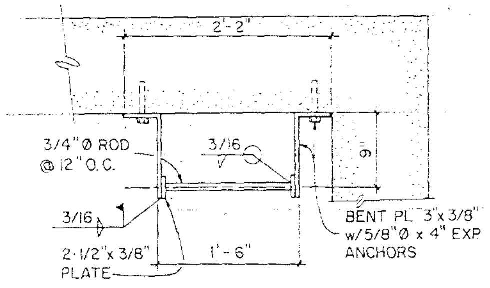
1. CAST-IN-PLACE CONCRETE: 28 DAY DESIGN STRENGTH OF 4000 PSI MINIMUM.
2. CONCRETE REINFORCEMENT: ASTM A615, GRADE 60
3. WATERSTOP: 9" P.V.C. TYPE NO. R89-12, CENTER BULB BY VINYLEX CORP.
4. MISCELLANEOUS STEEL: ASTM A36



INLET STRUCTURE 1/2"=1'-0"
PLAN
0 1 2 4

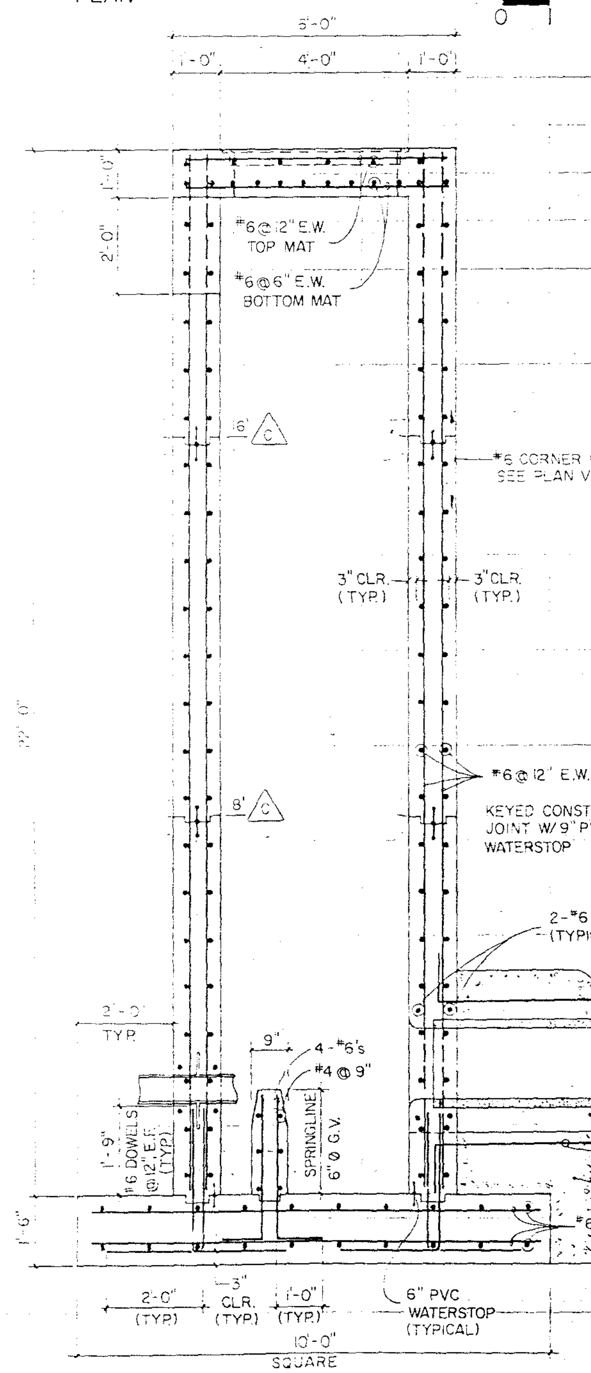


MECHANICAL DETAILS N. T. S.
PLAN

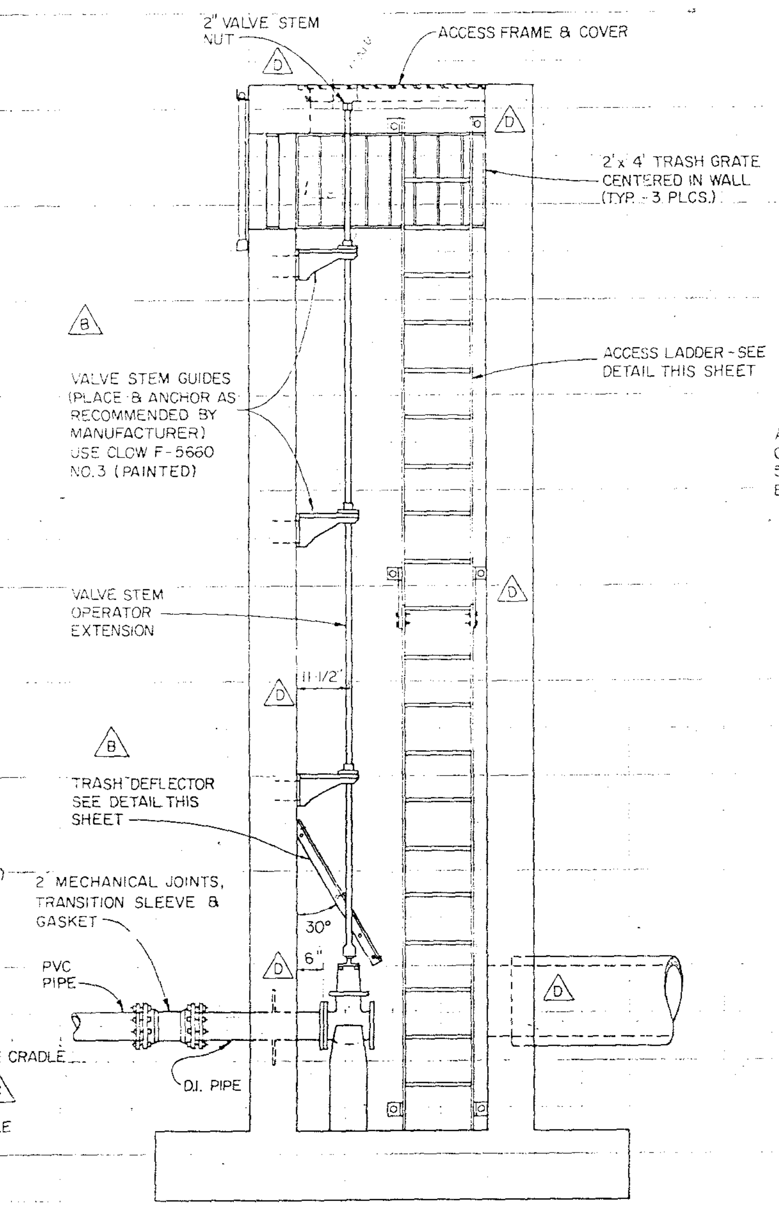


GALVANIZED LADDER ASSEMBLY 1"=1'-0"
DETAIL
0 0.5 1 2

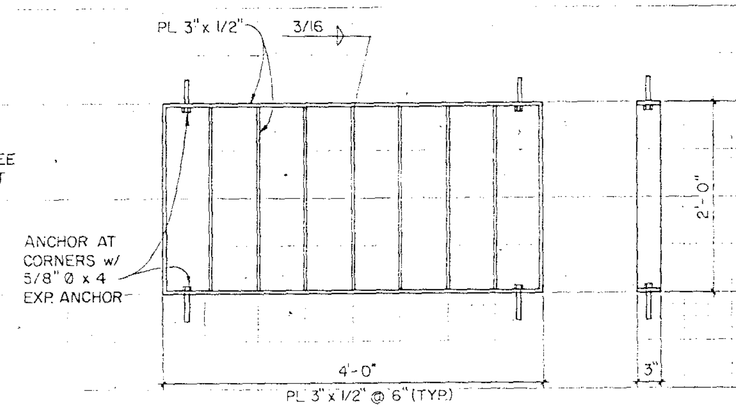
[redacted]



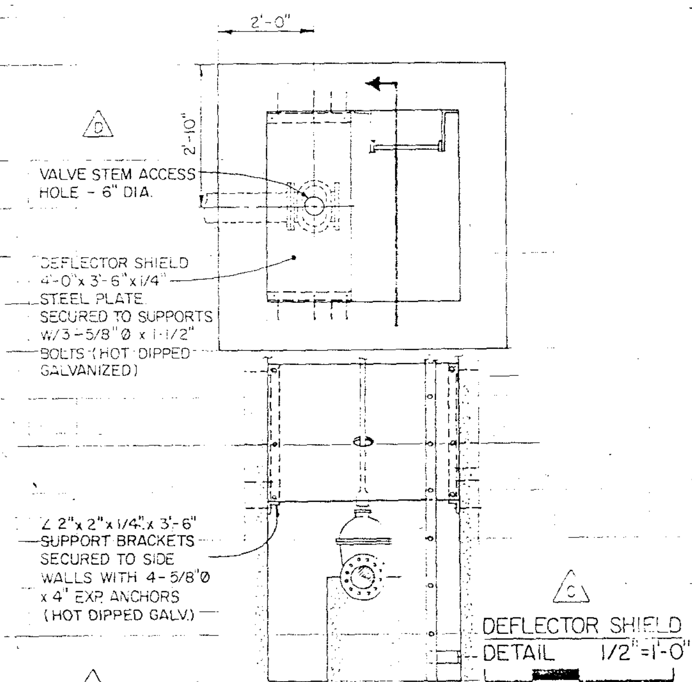
A 4/5 INLET STRUCTURE 1/2"=1'-0"
SECTION
0 1 2 4



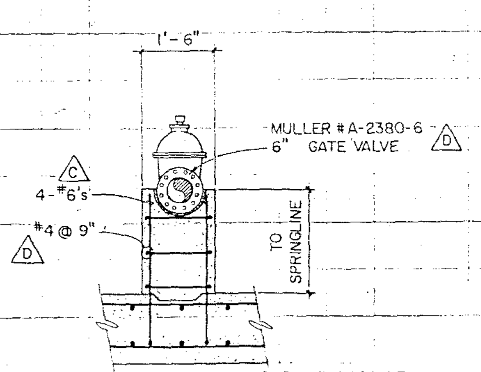
B 4/5 MECHANICAL DETAILS 1/2"=1'-0"
SECTION
0 1 2 4



GALVANIZED TRASH GRATE 1"=1'-0"
DETAIL
0 0.5 1 2



DEFLECTOR SHIELD
DETAIL 1/2"=1'-0"
0 0.5 1.0 2.0



AS BUILT
PROJECT RECORD DRAWINGS

PIPE SUPPORT 1/2"=1'-0"
DETAIL
0 1 2 4

SYM	DESCRIPTION	DATE	RFP	DOE	CLASS	JOB NO.
D	AS BUILT	7/31/84	RP JC	DF		440505
C	MISCELLANEOUS REVISIONS	4/18/84	WR JC	DF		440505
B	MISCELLANEOUS REVISIONS	3/15/84	WR	DF		440505
A	ORIGINAL ISSUE	2/27/84	W/C W/C	DF		440505

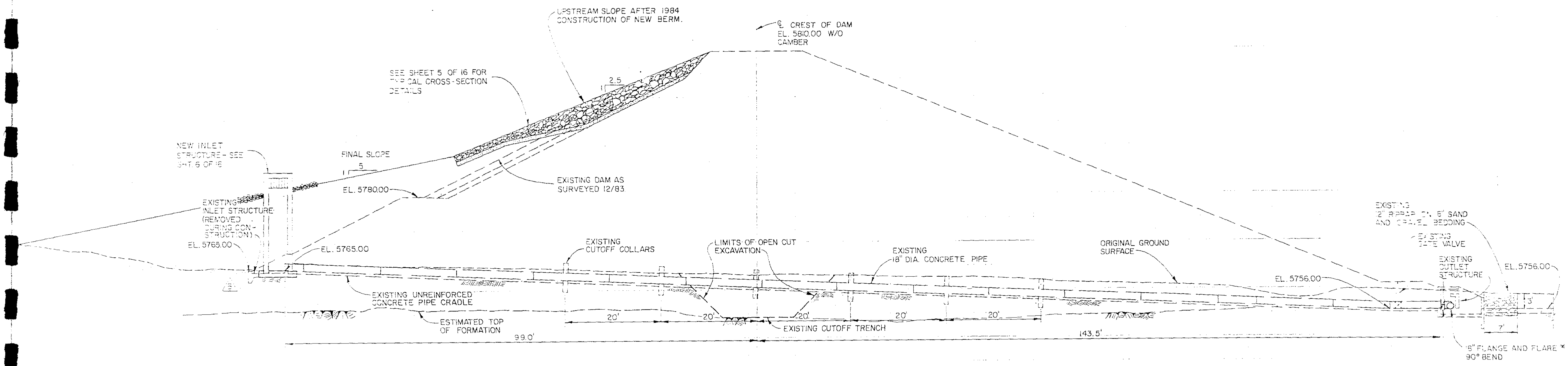
TOLERANCES		BY	DATE
FRACT. ±	DESIGNED	W/C	3/84
ANGLE ±	DRAWN	REESE	3/84
DEC. ± UNLESS NOTED OTHERWISE	CHECKED		3/84
	APPROVED		7/3/84
REMOVE BURRS AND SHARP EDGES			
NEXT ASSEMBLY			
SCALE:	SUBMITTED		
	APPROVED RFP		3/17/84
	APPROVED DOE		3/17/84

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE GOLDEN, COLORADO

MERRICK

B-5 DAM REPAIR
INLET STRUCTURE DETAILS

SIZE	DRAWING NUMBER	ISSUE	SHEET
D	28895-006	D	6 of 16

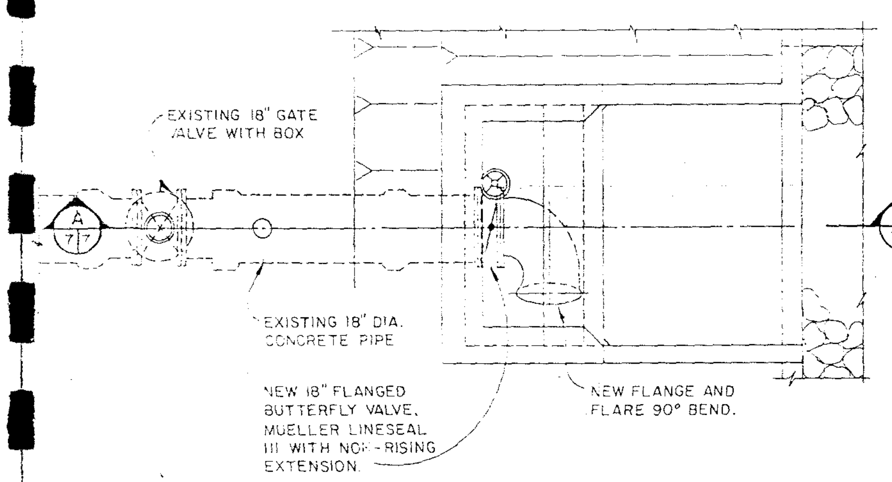


SECTION

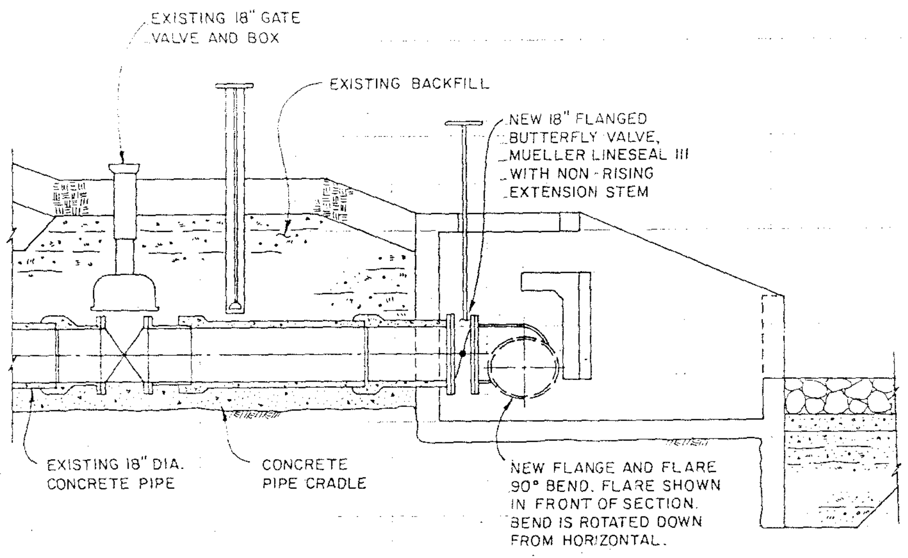
5 0 10 20
SCALE IN FEET

MAXIMUM CROSS-SECTION

STATION 4+15±



PLAN



SECTION A

OUTLET STRUCTURE DETAIL

1 0 5
SCALE OF FEET

DRAFT

[redacted]

AS BUILT
PROJECT RECORD DRAWINGS

B	AS BUILT	7/3	RP			SE 440505
A	ORIGINAL ISSUE	7/3				SE 440505
SEL	DESCRIPTION	DATE	RFP	DOE	CLASS	JOB NO.

TOLERANCES		BY	DATE	U.S. DEPARTMENT OF ENERGY, ROCKY FLATS AREA OFFICE, GOLDEN, COLORADO
FRACT. ±	DESIGNED	W/C	5/84	
ANGLE ±	DRAWN	PARKS	5/84	MERRICK
DEC. ± UNLESS NOTED OTHERWISE	CHECKED	J. LANG	7/84	
REMOVE BURRS AND SHARP EDGES	APPROVED	D. Fogle	7/9/84	B-5 DAM REPAIR MAXIMUM CROSS SECTION
NEXT ASSEMBLY				
SCALE: AS NOTED	SUBMITTED / APPROVED RFP / APPROVED DOE			SIZE D · DRAWING NUMBER 28895-007 · ISSUE B · SHEET 7 OF 16